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COMPRESSED AIR MAGAZINE

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DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. xvi

SEPTEMBER, 1911

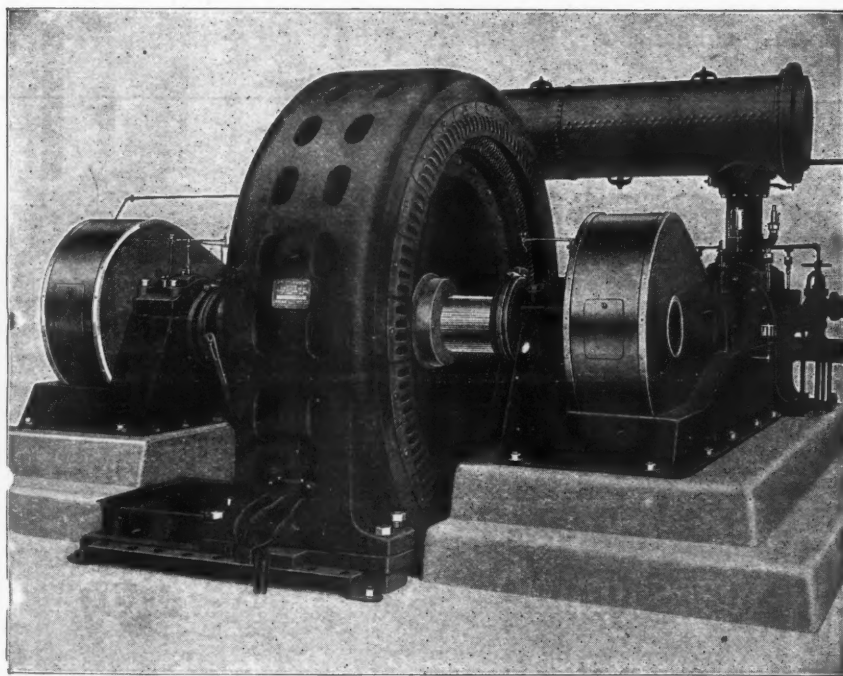
No. 9



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Motor Driven Air Compressor

Furnished

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AT PORT HENRY, N. Y.



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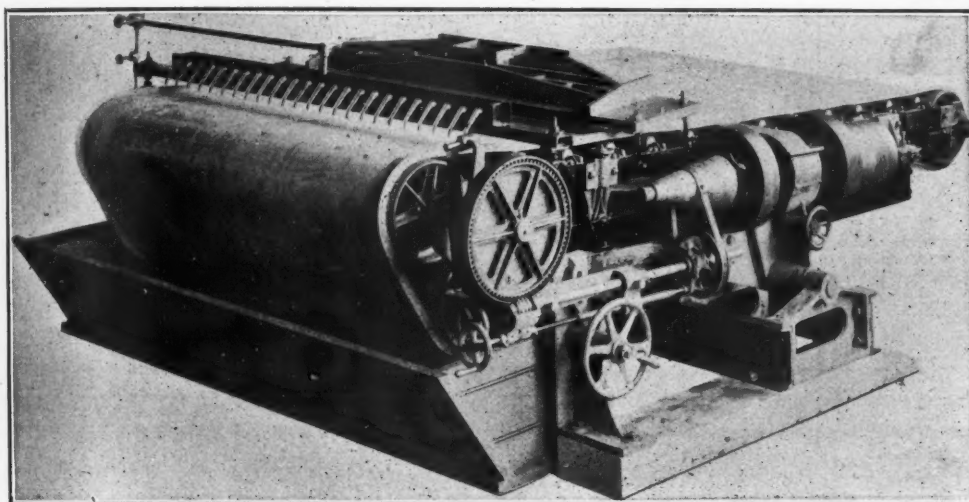
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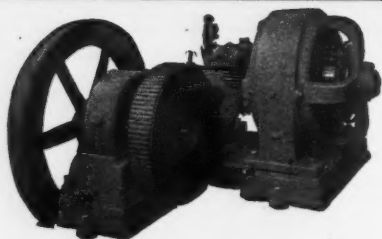
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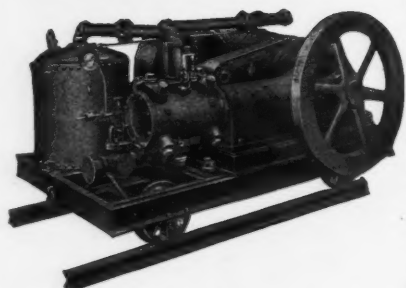


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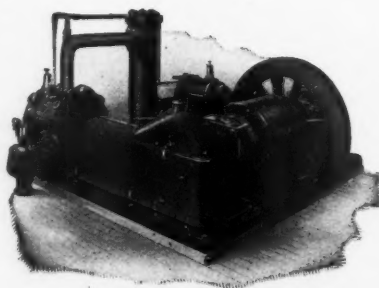
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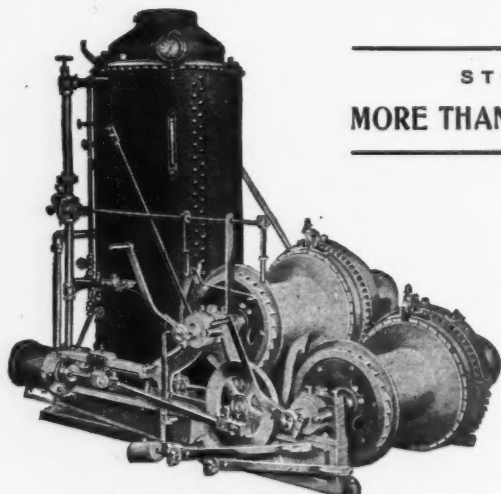
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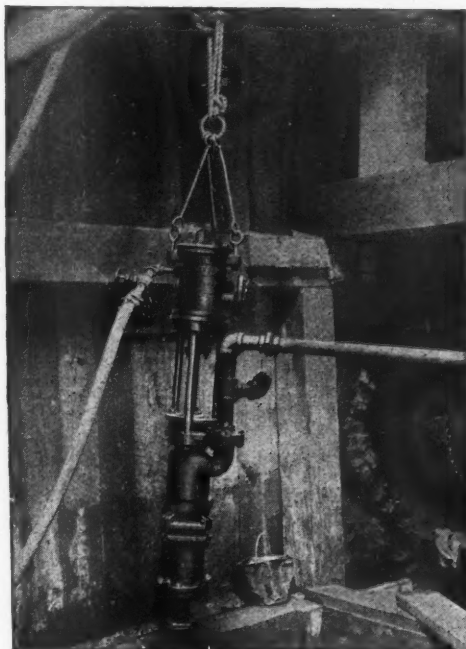
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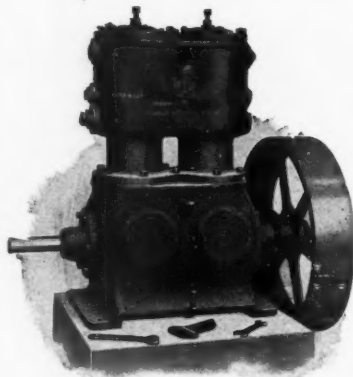
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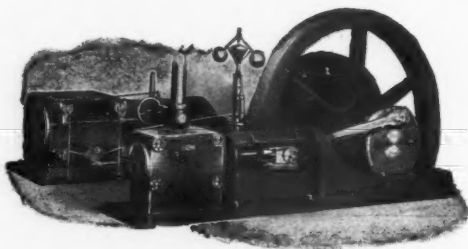
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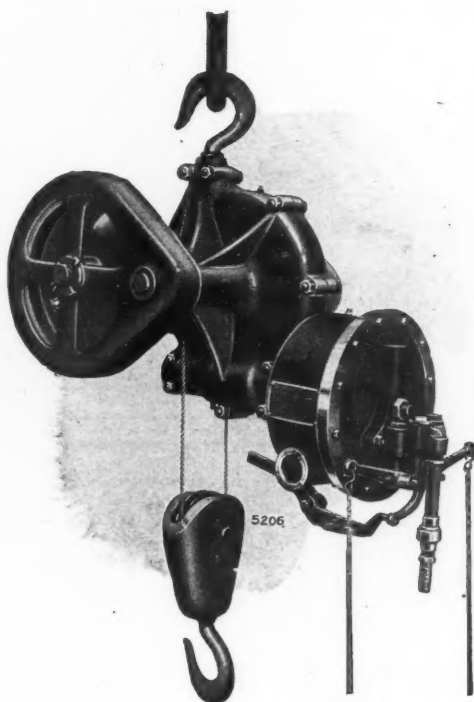
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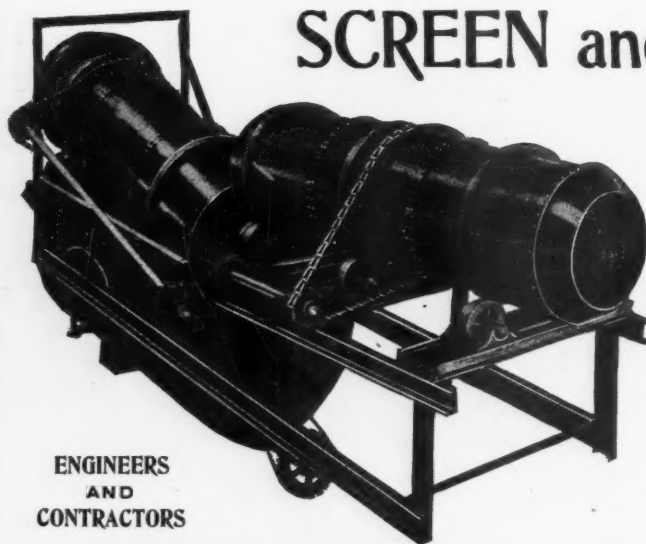
INDEX TO ADVERTISERS.

Atlantic Refining Co.....	9	Janney, Steinmetz & Co.	14
Black Diamond	12	Jarecki Mfg. Co.....	16
Boiler Maker.....	18	Jewett.....	14
Borne, Scrymser Co.....	18	Lidgerwood Mfg. Co.....	4
Brown & Seward.....	15	McKiernan-Terry Drill Co.....	18
Baldwin Locomotive Works, The.....	11	McNab & Harlin Mfg. Co.....	12
Bury Compressor Co.....	Back Cover	Mason Regulator Co.....	6
Cameron Steam Pump Works, A. S.....	5	Metric Metal Works.....	19
Chicago Pneumatic Tool Co.....	Front and Back Cover	Mines & Minerals.....	
Continental Oil Co.....	9	Mining & Scientific Press	
Cooper Co., C. & G.....	6	National Brake & Electric Co.....	13
Curtis & Co. Mfg. Co.....	16	Oldham & Son Co., Geo.....	17
Dixon Crucible Co., Jos.....	10	Pangborn Company, Thomas W.....	10
Engineering Contracting.....		Penberthy Injector Co.....	17
Engineering Digest.....		Porter Co., H. K.....	11
Engineering Magazine.....		Powell Co., Wm.....	14
Engineering News.....		Proske, T. H.....	9
Fiske Bros. Refining Co.....	2	Quarry.....	
Galigher Machinery Co.....	3	Republic Rubber Co.....	10
Gardner Governor Co.....	6	St. John, G. C.....	19
Goodrich Co., The B. F.	2	Standard Oil Co.....	9
Harris Air Pump Co.....	12	Stearns-Roger Mfg. Co.....	8
Ingersoll-Rand Co.....	7 and 15	Sullivan Machinery Co.....	4
		Vacuum Oil Co.....	9
		Westinghouse Air Brake Co.....	Back Cover

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Rich "Fines" by Screening
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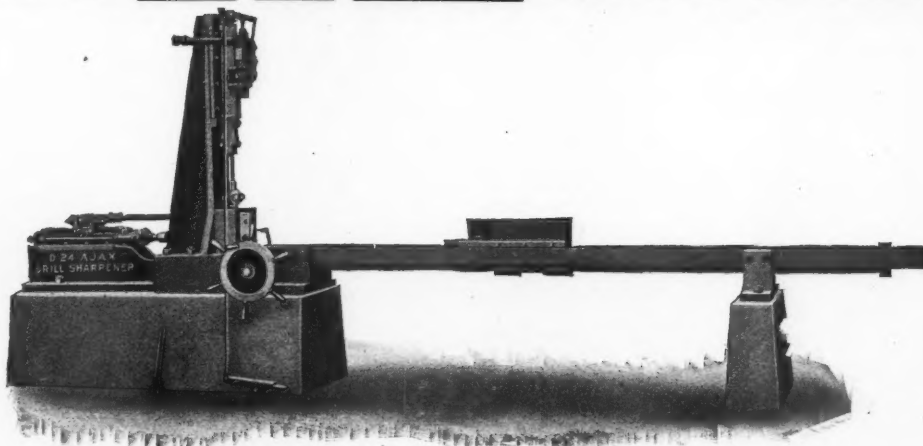
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BECAUSE—

They use Ingersoll-Rand Drills for hammers, making it possible to secure duplicate parts of these most important features *anywhere*.

All parts are made much heavier than even the most severe stresses upon them require.

The dies and dolly are much larger, insuring long life and low cost of renewal.

Mfg. by T. H. PROSKE,
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They can be operated either as right or left-handed machines—an exclusive "Ajax" feature.

They use no power when not actually sharpening drills.

They will sharpen drills faster and better than any other known way.

They are more economical in operation and upkeep, and will outlast any other sharpener.

Sold by INGERSOLL-RAND CO.
All over the world.

For Use on the Leading Makes of Air Compressors

ARGON COMPRESSOR OIL

For Air Cylinders of Electric-driven Compressors.

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For Air Cylinders of Steam-driven Compressors.

VACUUM 600 W CYLINDER OIL

For Steam Cylinders of Compressors.

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OVER 500 PLANTS

Are Making Bigger Profits Every Day by Using
**PANGBORN HIGH PRESSURE
SAND-BLAST**



If the character and volume of your output, in our judgement, will make it **PAY YOU**, we'll send it to you, have one of our Sand-Blast Instructors start it off, and teach your men how to use it.

Then, after 10 days trial, if you are not fully satisfied that you need it, and it will **PAY YOU WELL**, send it back! The trouble and expense are ours!

"If the **INVESTMENT** don't pay you—the **SALE** don't pay us."

THOMAS W. **PANGBORN** COMPANY
JERSEY CITY

Works and Showrooms: 56 Hudson Street

SAND-BLAST SPECIALISTS

Dixon's Pipe Joint Compound

will be found better than red or white lead for the making up of all threaded connections.

Dixon's Compound is a lubricant rather than a cement and so not only assists in making tight joints, but permits of easy disconnection.

Booklet 188-D free on request.

JOSEPH DIXON CRUCIBLE COMPANY
Jersey City, N. J.

The Republic Rubber Co.

Manufacturers of

High Grade Hose

for Steam, Air Drill, Suction, Water, etc.

Rubber Belting and Valves

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**PITTSBURG
SAN FRANCISCO**

Tell the Advertiser You Saw His Ad. in COMPRESSED AIR MAGAZINE.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. xv

SEPTEMBER, 1911

No. 9

AIR COMPRESSOR TESTING

BY FRANK RICHARDS.

It happens probably more frequently than otherwise that the large manufacturers are not to any great extent the users of their own products, and they consequently labor under the disadvantage of not being able to inform themselves except at second-hand of the condition, efficiency and general satisfactoriness or otherwise of their output. Of course, under such conditions, if special precautions are not taken and means of obtaining specific and precise information are not adopted, incorrect design, unsuitable or defective material and bad workmanship may pass undetected, and improvements may not be expected to be developed.

The builders of air compressors may be said to be in the predicament here indicated, they, of course, having no use for the compressors they build, at least in the variety turned out to suit the various demands as to capacity, pressure, etc., and accordingly the experience of the larger and longer established builders has enforced the necessity of, as some might think, going out of the way to get intimately acquainted with the workings of their own machines.

I have before me a formal and elaborate report by Mr. A. Hoffman, of a test of a compound steam and two-stage air compressor made at the shops of the Ingersoll Rand Company, Phillipsburg, N. J., a report which would be welcomed as a valuable contribution to the transactions of one of the big engineering societies. Being, however, so complete and exhaustive it is necessarily in the nature of a confidential and inside communication to the company and cannot at present be given to the public.

The compressor tested was of the following dimensions: Steam cylinders, 20 and 38 inch diameter; air cylinders, 33¼ and 20¼ inch diameter, with a common stroke of 30 inches and a free air capacity at maximum speed approximating 3,000 cubic feet per minute. The report had to do entirely and exclusively with the air end of the machine.

VARIETY OF INDICATOR WORK.

The indicator cards were taken on different days and under different conditions. The report says: "On October 30, the indicating was done with our regular reducing wheel motion on the Tabor indicators, while on November 1 we used the pantograph reducing motion. In reference to the relative merits of these two motions I can say that both motions would give accurate cards, only that with the reducing wheel running at high speeds defects may occur in the cards at both ends of the stroke, that is in the re-expansion curve and in the beginning of the compression curve. This is on account of the backlash when stopping and starting the string at the ends of the stroke. With the pantograph this trouble does not exist, because the motion of the string is only about 4 inches, but even with the pantograph you have to be careful not to get any stretch in the string, because such a stretch would be such a large proportion of the total movement. We therefore found it necessary to use wire from the pantograph motion to the indicator.

"On October 3d, we took the air into the compressor simply through the regular atmosphere intake, taking the air from the shop, but on November 1 we attached about 8 feet of pipe to the atmospheric intake.

"After taking the cards from both ends of

both air cylinders at different speeds, we also indicated the discharge pipe connections from both cylinders. This was done by making an opening on the low pressure side in the leg of the intercooler and piping down to the indicator. On the high pressure side an opening was tapped in the water trap between the intercooler and the inlet to the high pressure cylinder and a connection from this opening made to the indicator. By means of these pipe indicator cards the pressure loss was determined between the discharge of the low pressure cylinder and the inlet to the high pressure cylinder, and thus the pressure drop through the intercooler. The results of this are all given in the tabulation at the conclusion of this report."

This tabulation or summary of deductions from the testimony of the indicator cards, systematically arranged for the different speeds and the various delivery pressures, included some 200 items preceded by the mathematics and other particulars involved in detail, the whole being altogether too voluminous for reproduction in the ordinary technical journal and also containing information which may become the basis for reliable business guarantees of performance, but which may not yet be given unrestricted publicity. I am permitted, however, to call attention to a section of the report which presents some novel and original investigation of the operation of the water jacket and the accounting for the heat thereby abstracted in the final balance of power expended and results realized. What follows is reproduced verbatim from the report.

WATER JACKET DEDUCTIONS.

"I have given what is called the heat balance of the low pressure cylinder at 108 r. p. m., and this needs some explanation. It is well known from the principles of thermodynamics that the foot pounds of work done in any compressing cylinder during any period of time, say one minute, is equal to the increase in temperature caused in compressing the air multiplied by the weight of the air and the specific heat of the air, all multiplied by Joule's equivalent to reduce the whole thing to foot pounds.

"In making up the heat balance I tried to find out if this would check out in practice, and I find that it does most excellently; in fact it checks closer than we would expect it to.

"If the above is true the work done in the

cylinder must be equal to the heat given to the air cylinder water jacket plus the heat contained in the air after leaving the cylinder above the temperature of the intake air. Therefore I find that the heat given to the jacket is 2070 B. T. U. per minute, equivalent to 48.8 I. H. P. The heat contained in the air above the intake temperature of 77 degs. is 8320 B. T. U. per minute, equivalent to 196.3 H. P. The total B. T. U. is the sum of these two quantities, or 10,390 B. T. U., equal to 245 I. H. P. Theoretically, this total should be equivalent to the actual horsepower indicated in the low pressure air cylinder, and we find that this horsepower really is 243, which is also equivalent to 10,300 B. T. U. per minute. The discrepancy, therefore, is only equal to 2.1 horsepower. We would expect a greater difference than this, because we have figured the actual amount of air from the volumetric efficiency of the indicator card, which we know is not absolutely correct.

"There is also a slight discrepancy due to radiation of the outside air into the water jacket, but this is very slight because I took the temperature of the water leaving the jacket before the compressor was started, and as near as I could read the thermometer it was the same as the temperature of the cold water in the main.

WATER JACKET COOLING AFTER THE COMPRESSION.

"Our first thought would be that there was something wrong in regard to these results, because they show that about 20 per cent. of the total work indicated in the cylinder was given up to the water jacket, and according to this we should yet considerably better than isothermal compression, which of course would be an impossibility. The explanation is as follows:

"Very little heat is given to the water jacket while the air is being compressed, because the compression begins at a low temperature, and maximum temperature is not reached until the end of the compression, and while it is at its maximum temperature the piston is traveling very fast and does not have a chance to give up much heat. After the discharge valves open, however, a great deal of heat is given to the jackets because during this whole time the air is at its maximum temperature and it also comes in intimate contact with the jacket of the air cylinder head in passing out through the valves; in addition to this the piston is

traveling at a comparatively slow speed toward the end of the stroke. Some heat is also given to the jacket while the air is passing out through the discharge passage.

"This explanation is sufficient to account for the large amount of heat given to the jacket, and it shows that jackets really do more good than is usually supposed. Of course heat given to the cylinder jacket while the air is discharging does not reduce the work in the cylinder, but merely lowers the temperature of the air and raises the temperature of the jacket water." From *Power*, with additions by the writer.

CONDITION OF THE GAS IN COAL

In some cases the volume of gas liberated from broken coal is greater than the volume of the coal itself—that is, of the actual solid and the cellular space combined. Several theories have been proposed to account for this fact. If the inclosed gas is mechanically imprisoned in the microscopic pores of the coal, it must be under a pressure greater than that of the atmosphere; otherwise it would occupy after its escape a volume less than that of the coal. It is possible, furthermore, that there is a continual slow formation of methane by chemical decomposition of the coal, or it may be that the gas is held in a state of occlusion—that is, either dissolved molecularly or absorbed upon the inner surfaces of the cellular spaces. The gas which escapes from coal has been very often called "occluded gas", but, as Chamberlin has made plain, the word "occluded" has been loosely used in this connection, and the radical difference between mechanical imprisonment and true occlusion or condensation has been generally overlooked.—*Bureau of Mines*.

COSTS OF UNWATERING WITH THE AIR LIFT*

An interesting experiment was made in 1910 at El Cobre Mines, Cuba, in which an air lift was used for unwatering the mines.

The water stood at the 200-ft. level, held by two Cameron station pumps. The shaft was 800 ft. deep, with one cage road, 4 × 8 ft., open to the 800-ft. level. The other compartments were blocked with platforms. The

water was acid, and contained up to 400 grs. Cu. per cu. meter. A tunnel from the 50-ft. level through the mountain allowed a reduction in the head.

Tests showed the shaft to be blocked by old timber and guides, so that a cone was made to run on an old cable guide, lowered in the center of the compartment with a 2-ton weight. The wood pipe was built upon this and lowered as put together.

The wood pipe twisted around the center cable in a spiral, so that it had made a complete turn in 200 ft. without doing the slightest harm. Three columns were built up on the cone and tied together with new 1½-in. rope, which, when wet, held them together firmly. They were 750 ft. long, each, and had no support, as the guide and lowering ropes were soon eaten off by the water. With 600 ft. under water and 150 ft. above, the wood columns were nearly floating. After being water-soaked they became very heavy. The wood pipe was 10 in. inside diameter. Air pipe was 2½-in. iron pipe, which was thoroughly tarred and changed as it was eaten by the water. The high limit of the compressors was 140 lbs. pressure. Two pipes were used, the third being in reserve and operated in case of breaks in the others. The out-flow was measured hourly by weir.

The head at the start was 150 ft. submergence of air pipe 50 per cent. Head of finish was 360 ft., with 39 per cent. submergence. The water removed was 113,120,000 gallons, at a cost of 7.434 cts. per 1,000 gallons.

The pipes averaged 950 gallons per minute, each, or 105 cu. ft. of air for 100 gallons of water.

The lowest speed was with a 360 ft. head, 1,500 gallons per minute for the two pipes, or 160 cu. ft. of free air for 100 gallons of water.

Second Stage.—After reaching the 400-ft. level, a 2,000-gallon pump was installed, and the discharge of the blow pipes turned into the pump sump. Under no head, one 10-in. pipe threw 2,200 gallons per minute with air cut down. This was the pump limit on a burst of speed.

A special test was made in lowering the water for seven days. The results were as follows:

SEVEN DAYS' TEST BLOWING AND PUMPING.

Feet lowered	57 ft. 6 in.
Feet lowered per day	9 ft. 2½ in.

*From an article by E. H. Emerson in School of Mines Quarterly of Columbia University, July, 1911.

Gallons per ft. lowered..... 307,100
 Total gallons pumped.....17,659,980
 Total gallons pumped per day..... 2,522,954
 Total gallons pumped per minute... 1,750
 Head at start on blow pipe.....21 ft. 6 in.
 Head at finish on blow pipe..... 79 ft.
 Average head50 ft. 3 in.
 Submergence at start..179 ft. = 89 per cent.
 Submergence at finish..100 ft. = 50 per cent.
 Air used, 100 lbs. pressure.
 2½-in. air pipe inside 10-in. wooden pipe, one
 pipe only used.
 42.3 cu. ft. of free air to 100 gallons of water.
 Cost: 2.32 cts. per 1,000 gallons.

In this case the pipe was limited by the capacity of the pump. 3,500 to 4,000 cu. ft. could be blown from the one pipe with 1,000 cu. ft. of free air. The actual inflow of the mine is 213 gallons per minute.

The cost per 1,000 gallons by blowing down 60 ft. once in two months, and pumping the water to the surface, is 5.23 cts. per 1,000 gallons.

The cost of the pump alone, working under full capacity, is 2.91 cts. per 1,000 gallons (with labor proportioned to the blowing), but handling only the inflow with pumps of small size the cost was 8.3 cts. per 1,000 gallons. There is, therefore, a saving of 3.02 cts. per 1,000 gallons by the combination method of holding the water at the 400-ft. level.

It is a real saving, since in flood time the full 2,000 gallons capacity is necessary, and, therefore, there is no unnecessary investment. A great advantage is that an enormous sump is provided, which insures against drowning by the sudden floods.

ELECTRICITY IN MINES

The following we extract from a letter to the *Colliery Guardian* by an English mine owner and Member of Parliament.

I have always made it a rule at the collieries with which I am connected that no electricity shall be used in any working place or part of a mine where gas is present. There are very few men in this country who have installed more electricity in mines than I have, and for more than ten years I have been continually raising in the House of Commons the question of the use of electricity, believing that its use ought to be prohibited in all mines where cables and machines are working in an atmosphere charged with gas.

Protective devices are all very well as far as they go, but all mechanical devices are

subject to accidents; especially so is this the case where the appliances are of the most delicate character.

I have never yet met a colliery manager who prefers to carry electricity into a working face where gas is present if he could have a supply of compressed air for coal-cutting or haulage purposes. It may be argued that ½ per cent. of gas is in no way dangerous, but the answer is that where ½ per cent. of gas is present more may appear at any moment.

Only last week the question of carrying electricity in-by in a large mine in the intake airways for haulage purposes was discussed at the board meeting of one of my companies. The directors, acting under the advice of Mr. Charles Rhodes (their consulting engineer) unanimously decided not to use electricity in-by, even though the intake airways were free of gas, owing to danger from dust, and it was therefore decided to use compressed air—naturally at a considerably increased cost—for the sake of safety.

I cannot for the life of me understand how any colliery people can claim to have the right to work coal conveyors and coal-cutting machinery in working places where lamps at times are put out owing to the presence of gas. Where electricity is used and gas is present there is always a grave element of danger. The industry requires to be protected against madmen and idiots who deliberately take this risk. Some day sooner or later—unless the law is altered to deal with these reckless people—an explosion will occur, and in view of the large number of men employed in some of the big mines of this country the death roll might be so appalling that Parliament would have no hesitation, and rightly so, in having electricity taken out of all mines.

COMPRESSED AIR CONCRETE MIXER

The Drake Standard Machine Works, 1025 West Jackson Boulevard, Chicago, have manufactured the Pneumatic Conveying Mixer, used to mix and convey concrete through pipes to place. The machine is an invention and patent of Mr. S. H. McMichael.

The mixer consists of a hopper, which is kept flush with charging platform, the bottom of which is provided with a slide, to hold the charge until it is ready to be admitted to the mixer proper. This consists of a cast iron chamber, of 6 cubic feet capacity, above which

there is an air tight rocker valve, which is closed when the charge has been admitted. The capacity can be increased to 24 cubic feet by fitting on a cylindrical extension. The bottom of the chamber is connected to the pipe line by means of a reducer. When the charge has been admitted to the chamber through two pipes, one of which is connected immediately below the valve, to secure downward pressure on the material in the chamber, and the other enters the pipe in the ell below the reducer, forcing air into the straight section. The air entering the chamber at about 85 pounds pressure, producing an initial velocity in the material of about 35 feet per second. The material travels in the pipe mixed with nearly double the volume of air, reducing the frictional resistance. The frictional resistance aids in mixing the concrete, in this that the outer material is retarded by the friction against the pipe and the material in the center travels faster than that on the outside. As the materials travel with different velocities, on account of friction, and also on account of the difference in size, surface and specific gravities of the particles, a good mixture is secured.

Limestone of $\frac{3}{4}$ -inch size is used for aggregate. The pressure varies with the distance of delivery of concrete. An ordinary type of compressor is used for the work. This type of mixer is being used at present in the construction of the La Salle tunnel in Chicago.

MEASUREMENTS OF SUBTERANEAN TEMPERATURE

The deepest hole in the world, up to date, is the boring begun ten years ago at Czuchow, Silesia, with the object of attaining a depth of 2,500 meters, and which has now reached a depth of 2,240 meters (7,349 feet). The bore is 44 centimeters in diameter at the top, and diminishes progressively to 5 centimeters. Measurements of temperature have been made regularly. At 2,220 meters the temperature is 83.4 deg. C. (182 deg. F.). This gives a "geothermic degree" (amount of descent corresponding to a rise of temperature of 1 deg. C.) in 31.8 meters. The change of temperature does not proceed uniformly. In fact an interesting "temperature inversion" occurs between the depths of 640 and 730 meters, where the temperature actually falls, with descent, about 2 deg.—*Scientific American*.

A GAS LIGHTER THAN HYDROGEN

The studies of Dr. A. Wegener, on the outer layers of the earth's atmosphere, lead him to the conclusion that in these outer layers there exists a hitherto unknown element (*Chem. Zeit.*, May 25, 1911). This element must be a gas lighter than hydrogen and possessed of but trifling inertia, as meteorites rush through it with scarcely diminished velocities of about 30 miles per second, and are only brought to incandescence by the friction of the denser hydrogen, which, according to Hann and others, is the principal constituent of the atmosphere at altitudes of 40 miles above the earth's surface.

PUFF FOR AN INVENTOR

Dope fiend and degenerate, his faculties befogged by the constant use of "coke," David Brown, a member of Butte's hophead community, possesses the brain of what might have been a successful inventor. In the moments when not sodden with the drug Brown has perfected a plan for a sanitary wash basin by means of which the clogging in pipes due to the present stopper can be eliminated. The plan is simple. There is a platform on the floor beneath the bowl and to this is attached a coiled spring which runs up the main pipe. By standing on this platform a person operates the spring so as to shut out the outflow from the bowl. When the weight is removed the water is given passage and allowed to flow out. A child's weight suffices as well as that of a grown person to operate this ingenious device, for which the inventor claims he has obtained a patent.—*Anaconda Standard*.

WORLD'S RECORD IN ROCK DRILLING BY HAND

In the international contest at Hancock, Mich., July 22, the hammer and drill team of Butte, Mont., made a new world record for drilling into solid granite. The penetration was 59 $\frac{1}{4}$ inches in 15 minutes, winning of \$1,000, offered by John R. Ryan, president of the Anaconda Copper Company.

The previous world's record was 56 inches made by the Butte team a year ago. The team is composed of John W. McCormick, W. J. McLain and Michael Kensella.

BUILDING CONCRETE DROP SHAFTS IN SHIFTING SANDS

By P. B. McDONALD.

In the past few years there have been a number of concrete drop shafts sunk in the Lake Superior iron region, notably on the Mesabi, Cuyuna, Swanzi and Marquette ranges, and in the bituminous coal region of the eastern and middle states. It seems likely that the use of compressed air for shaft sinking will gain favor, just as it has in bridge pier, tunnel and foundation work.

The favorite shape for the outside of the shaft is that of a circle. At first the inside also was made circular, and after partitions had been put in for skip and cageways, the odd spaces around the outside were utilized for pipe. Later practice makes the inside of the shaft rectangular. The Rogers shaft at Iron River, Mich., is 29 ft. outside diameter, and 16½ by 11 ft. inside at the bottom; there are three 6-in. offsets at intervals higher up, to allow leeway in aligning the guides for skips and cages. This shaft has very thick walls, but the weight is needed for forcing the cutting edge down through sand and boulders.

The principle of sinking the shaft previous to the turning on of compressed air, for holding back sand and water (and most of them are sunk some distance before the latter is necessary) can be likened to standing up a foot length of 4-in. pipe in the sand, and scooping out the material inside with a spoon, so that the pipe sinks gradually; more lengths of pipe are added at the surface as the first sinks, and the dirt and pebbles are scraped away from under the high-side, so that the tube sinks evenly. The shaft, however, is a reinforced concrete casing, with a pointed steel cutting edge, and the dredging is done with "clam shells" or by men shoveling into a bucket. The "clam shells" are used whenever possible, and the shaft is preferably allowed to fill with water, so that the dirt is washed in from under the shoe.

The steel shoe, made in sections of 90 degrees of ¾-in. steel, and re-enforced by vertical cross partitions of steel plate, held riveted to the shoe by angle irons, may be 3 or 4 ft. high. The sections are assembled on the site of the shaft, usually in a hole or excavation dug as a starter, and the shoe is filled with concrete.

The walls are built up above the shoe, within

circular steel forms on the outside and light wooden forms on the inside (if the interior is rectangular). During its gradual descent through the overburden, the shoe may become considerably bent from contact with boulders. When the solid ledge has been reached concrete is added to the pointed cutting edge, which is thus filled out flush with the rectangular interior of the shaft, and is "sealed" to the rock.

Re-enforcing rods in the concrete are of two kinds; both are of ¾-in. square steel or iron. The vertical rods are for preventing the

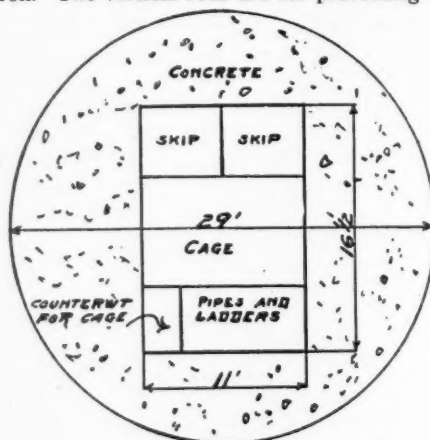


FIG. 1. SECTION OF ROGERS SHAFT. shaft from pulling apart, in case boulders dig into the side, and hold it back while the bottom portion continues to drop away. At the start there may be two rows of the vertical rods, one a few inches from the outside forms, and one row near the interior walls; they are spaced about 18 ins. apart, and the first set is usually fastened to the shoe.

Later as the shaft nears completion, the inside row is usually left off, and the outside row is spaced at intervals of 3 or 4 ft. The horizontal re-enforcements are bent in the arc of a circle, and are laid in the concrete near the outside walls, spaced at about the same distances as the vertical rods; they are for withstanding pressure from without—that of sand and water.

The concreting mixture should contain more cement than is specified for ordinary work, because in the case of a porous wall, compressed air will leak through, and later, when the shaft is finished, water will leak in. In loose overburden, after compressed air has been turned into the shaft, bubbles of the air can be seen

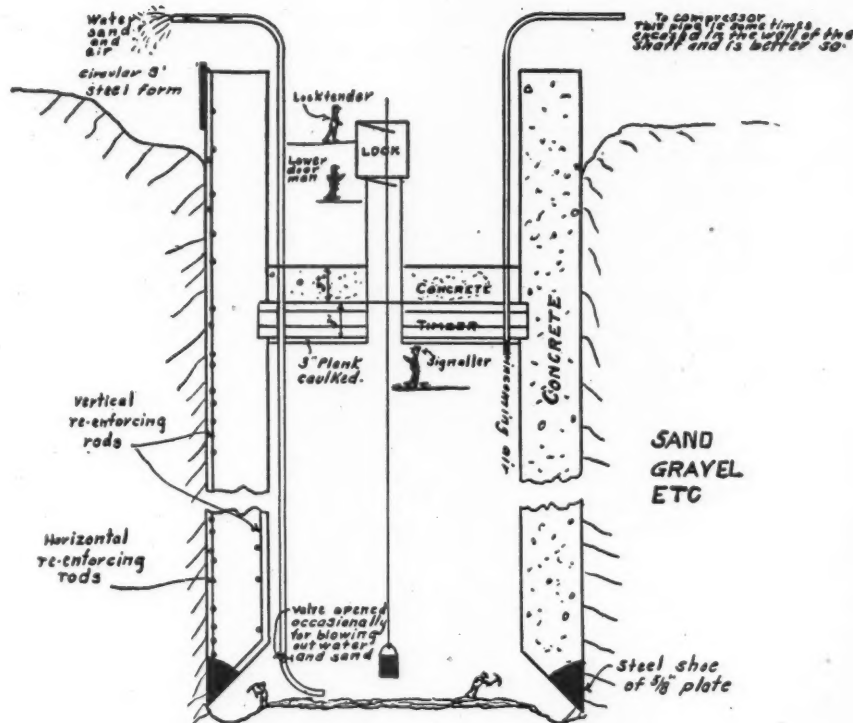


FIG. 2. SCETCH OF SHAFT SINKING OPERATION.

rising out of the ground in great quantity, close to the casing, and in some instances as far back as 100 ft from the shaft; this leaks through the walls and out under the cutting edge.

Preparatory to turning on compressed air for holding back sand and water, a timber deck is put across the shaft. Three 12-in. layers are fastened securely in a groove in the concrete; 3-in. planking underlies this, and is calked tight with oakum. Over the 12 by 12-in. timbers is put 2 or 3 ft. of concrete. In spite of this 6 ft. of caulked timber and concrete, air will leak through, and impervious clay must be kept plastered on the under side of the plank.

When air pressure is turned on, the work consists of digging a ditch around under the shoe a foot or two deep, the dirt being thrown in the center, and later hoisted. This may require a little blasting in hard ground, but usually pick and shovel work will suffice; perhaps two or three days are taken (with each man working say two 40-minute shifts in 24 hours, there being 12 or 15 shifts).

The last shift comes up, the air is let suddenly out of the shaft through two or three exhaust valves opened simultaneously (perhaps 4 minutes being taken for the air to escape), and the casing should drop down an amount equal to the depth of the ditch dug. In case it hangs up from friction on the sides, it is sometimes necessary to explode several sticks of dynamite (in the water which has run in), for shaking or jarring the casing down. Occasionally the shaft has been weighted with pig iron or wet sand for forcing the cutting edge through the loose dirt, which runs in under the shoe, when the air is allowed to escape. The air is blown out because its pressure holds the shaft up against the force of gravity. The greatest difficulty encountered in the whole process is from skin-friction on the sides of the shaft, which prevents the dropping down, and in extreme cases the casing has to be left hung up, and a concrete appendix built from the shoe down to the solid rock. The incoming air lines are often encased in the concrete walls, especially if much compressed air work is anticipated. When the pipes merely go

through the timber deck, the air heated by compression makes the top of the chamber almost unbearably hot, so that not infrequently the men are overcome by the heat. This is particularly liable to happen to the man who works just under the timber deck giving signals and guiding the bucket into the hole.

[This hot air is an unnecessary hardship on the men. An aftercooler should be used. Ed. C. A. M.]

Fifty pounds of air is the limit of endurance for men to work in. With 40 lbs. pressure per square inch two 40-minute shifts are worked per man per 24 hours.—*Condensed from Mining and Engineering World.*

AIR CONDITIONING FOR FACTORIES

By C. E. A. WINSLOW.*

I am quite frankly and coldly treating the operative as a factor in production whose efficiency should be raised to the highest pitch, for his own sake, for that of his employer, and for the welfare of the community at large. The intimate relation between the conditions which surround the living machine and its efficiency is matter of common experience. Contrast your feelings and your effectiveness on a close, hot muggy day in August and on a cool brisk bright October morning. Many a factory operative is kept at the August level by an August atmosphere all through the winter months. He works listlessly, he half accomplishes his task, he breaks and wastes the property and the material entrusted to his care. If he works by the day the loss to the employer is direct; if he works by the piece the burden of interest on extra machinery has just as truly to be borne. At the close of the day the operative passes from an overcrowded, overheated workroom into the chill night air. His vitality lowered by the atmosphere in which he has lived, he falls a prey to minor illness, cold and grip, and the disturbing effect of absence is added to inefficiency. Back of it all lurks tuberculosis, the great social and industrial disease which lays its heavy death tax upon the whole community after the industry has borne its more direct penalty of subnormal vitality and actual illness.

The remedy for all this is not simply ven-

tilation in the ordinary sense in which we have come to understand the term. Conditioning of the air so that the human machine may work under the most favorable conditions,—this is one of the chief elements of industrial efficiency as it is of individual health and happiness.

The chief factors in air conditioning for the living machine, the factors which in most cases far outweigh all others put together, are the temperature and humidity of the air. Heat, and particularly heat combined with excessive humidity, is the one condition in air that has been proved beyond a doubt to be universally a cause of discomfort, inefficiency and disease. Flugge and his pupils in Germany and Haldane in England have shown that when the temperature rises to 80 deg. with moderate humidity or much above 70 deg. with high humidity, depression, headache, dizziness and other symptoms associated with badly ventilated rooms begin to manifest themselves. At 78 deg. with saturated air Haldane found that the temperature of the body itself began to rise. The wonderful heat-regulating mechanism which enables us to adjust ourselves to our environment had broken down and an actual state of fever had set in. Overheating and excess of moisture is the very worst condition existing in the atmosphere and the very commonest.

The importance of the chemical impurities in the air has dwindled rapidly with the investigations of recent years. It was long believed that the carbon dioxide was an index of some subtle and mysterious "crowd poison" or "morbific matter." All attempts to prove the existence of such poisons have incontinently failed. Careful laboratory experiments have quite failed to demonstrate any unfavorable effects from rebreathed air if the surrounding temperature is kept at a proper level. In exhaustive experiment by Benedict and Milner (Bulletin 136, Office of Experiment Station, U. S. Department of Agriculture), 17 different subjects were kept for periods varying from three hours to thirteen days in a small chamber with a capacity of 197.6 cubic feet in which the air was changed only slowly while the temperature was kept down from outside. The amount of carbon dioxide was usually over 35 parts (or eight to nine times the normal) and during the day when the subject was active it was over 100

*Associate Professor of Biology, College of the City of New York.

parts, and at one time it reached 231 parts. Yet there was no perceptible injurious effect.

The main point in air conditions is then the maintenance of a low temperature and of a humidity not too excessive. For maximum efficiency the temperature should never pass 70 deg. F., and the humidity should never be above 70 per cent. of saturation. At the same time a too low humidity should also be avoided. We have little exact information upon this point, but it is a matter of common knowledge with many persons that very dry air, especially at 70 deg. or over, is excessively stimulating and produces nervousness and discomfort. It would probably be desirable to keep the relative humidity between 60 and 70 per cent.

Another point which may be emphasized in the light of current opinion is the importance of "perflation" or the flushing out of a room at intervals with vigorous drafts of fresh cool air. Where there are no air currents the hot, moist, vitiated air from the body clings round us like an "aerial blanket," as Professor Sedgwick calls it, and each of us is surrounded by a zone of concentrated discomfort. The delightful sensation of walking or riding against the wind is largely perhaps due to the dispersion of this foul envelope and it is important that a fresh blast of air should sometimes blow over the body in order to produce a similar effect. The same process will scatter the odors which have been noted as unpleasant and to some persons potentially injurious. The principal value of the carbon dioxide test to-day lies in the fact that under ordinary conditions high carbon dioxide indicates that there are no air currents changing the atmosphere about the bodies of the occupants.

Continued progress is being made in the adaptation of ozone to the purification of drinking water for the supply of towns and cities. Apart from examples in America, the ozone plants at Chartres, Florence, Hermannstadt, Nice, Paderborn, Paris, Villefranche, and Wiesbaden are sufficient to demonstrate the scientific and commercial success of the system, whose claims have been further recognized by the decision of the Paris Municipal Council to erect two additional plants each of 9,900,000 gallons output daily, and by the 11,000,000-gallon plant recently completed at St. Petersburg.—*The Engineer*, London.

PANAMA AIR COMPRESSOR LUBRICATION

The following comes from an engineer correspondent of *Power*. It is a report of the use of lubricating oils in the three air-compressor plants of the Isthmian Canal Commission for the month of February, 1911. It shows the number of revolutions, square feet covered per pint of oil, output in cubic feet of air and the cost per million square feet covered.

	Empire Air Compressor	Las Cascadas Air Compressor	Rio Grande Air Compressor
Oils Used:			
Valve oil ..	87 $\frac{3}{4}$ gal.	22 gal.	38 gal.
Stationary-engine oil.	157 $\frac{1}{4}$ gal.	35 gal.	60 gal.
Air-compressor cylinder oil ..	87 $\frac{3}{4}$ gal.	23 gal.	45 gal.
Revolutions per gallon of valve oil:	236,458	295,655	217,650
Revolution per gallon of stationary-engine oil:	131,532	185,840	137,845
Revolutions per gallon of air-compressor cylinder oil:	236,458	282,800	183,682
Square feet covered per pint of valve oil:	1,041,107	1,392,597	1,025,122
Square feet covered per pint of air-compressor cylinder oil:	1,354,971	1,837,513	1,028,152
Cost per million square feet covered (surface):			
Valve oil....	\$0.0234	\$0.0175	\$0.0237
Air-compressor cylinder oil	\$0.0134	\$0.0098	\$0.0176
Output of free air, cubic feet:	378,879,661	118,770,526	151,205,582

In the air-compressor plants at Empire, Las Cascadas and Rio Grande, there are 14 compressors, each of 425 horsepower and all operating at a steam pressure of 125 pounds. The engines are simple twin cylinder. The compressors are of the double-cylinder cross-compound type. The area of the two steam cylinders is 9.42 square feet; the area of the low-pressure air cylinders is 15.17; the area of the high-pressure cylinders is 9.42 square feet. The speed of these compressors is from 127 to 137 revolutions per minute.

D. E. IRWIN.

Empire, Panama.

[This is, of course, interesting and the figures are of value for comparison of practice; but as here given the statement might be misleading. Of course one pint of cylinder oil never actually covered 1,800,000 square feet of surface, say 40 acres. There is no kind of surface upon which, spread so thinly, it would have made a visible stain, although it is probably entirely correct that this cylinder surface was swept by the piston while

the pint of oil was disappearing. We learn at least that effective lubrication does not consist in keeping the surfaces wet with oil, and where so little oil was found sufficient the question is at least suggested as to whether any at all was necessary.—Ed. C. A. M.]

AVIATION MAKES SPEED RECORDS

There would seem to be really no practical value to the devices which are being developed for navigating the air, and in the prospective employment of them for getting from one point to another at a considerable distance, except as it may enable one to get there in a shorter time. The mere attainment of high speed for any portion of a given flight without any other result than the record of the speed attained, is surely a matter of momentary curiosity or a condition for gamblers to deal with. Nevertheless, high speed records are being made and we all are more or less interested in them in spite of all the suggestions of common sense. The following upon the general topic we condense from a recent editorial in the *Engineering Record*.

The record of 155 miles an hour credited to Vedrine leaves every previous exhibition of human power to make time hopelessly in the rear: It is not only a new record of speed, but almost a new conception of speed that is given the world by this extraordinary performance. True enough, the aviator had a hurricane at his back and one of the very fastest machines in the world, a Morane monoplane, beneath him, but the combined result is certainly none the less awe-inspiring. Just how fast the wind was blowing and just how fast the monoplane was scudding ahead will probably never be known.

As a mere matter of mechanics the possibility of such speeds is inspiring. At the rate at which aeroplane speeds have increased for the last year or two it is going to be but a brief time before a hundred miles an hour is passed, and not much more before all records of things that travel on earth are passed. It may be long, however, before this prodigious flight of Vedrine's is beaten. At the present time there seems to be no difficulty in constructing a system of planes that will fly and fly well with sufficient power behind it. Increase over the present ordinary speeds for flying machines must come by increasing the engine

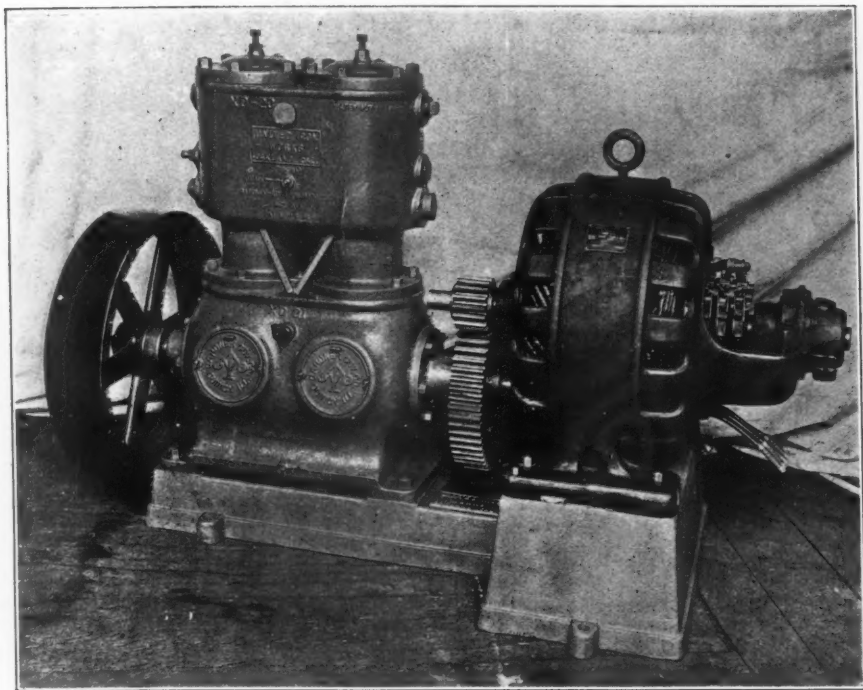
power, increasing the efficiency of the propeller or greatly decreasing the resistance of the plane for a given lifting power. It would not be in the least surprising if it were possible to construct propellers with perhaps half as much again thrust in proportion to the energy wasted as the best now in use. It is quite certain that there is a great difference in the efficiency of propellers as now constructed, especially with reference to their adaptation to the high speeds employed.

The whole engine question must soon be taken up by makers all over the world. The successful aeroplane engines are very few in number. Perhaps they have been pushed already quite near to their possible limit of power per pound of weight, and yet there is a good chance for improvement in the sense that it may be possible to get continuous performance of the highest class where one now gets only occasional and uncertain performance.

As to the decrease of resistance, something may be accomplished by the construction and shaping of the planes. It already appears that in the matter of speed the simple surfaces of the monoplane have a very material advantage, much on the same principle that a racing sloop has an advantage over a schooner of similar sail area. On the other hand, the temptation to cut down resistance by reducing supporting surface is a hazardous one. The less the surface the higher the speed must be to keep up, and the slimmer the chance of alighting safely if anything happens.

Taking it altogether, one may perhaps grow hopeful that when Vedrine's speed record finally succumbs, the following gale will play a much less important part in the result. Certainly a speed of nearly 200 ft. a second higher than has ever been reached by anything, except a projectile, is enough to satisfy even one's twentieth century enthusiasm.

"A sleeper is one who sleeps. A sleeper is that in which a sleeper sleeps. A sleeper is that on which the sleeper runs while the sleeper sleeps. Therefore, while the sleeper sleeps in the sleeper, the sleeper carries the sleeper over the sleeper under the sleeper, until the sleeper which carries the sleeper jumps the sleeper and wakes the sleeper in the sleeper by striking the sleeper under the sleeper on the sleeper."



COMPRESSOR FOR TRANSFERRING ACIDS.

SULPHURIC ACID HANDLED BY COMPRESSED AIR

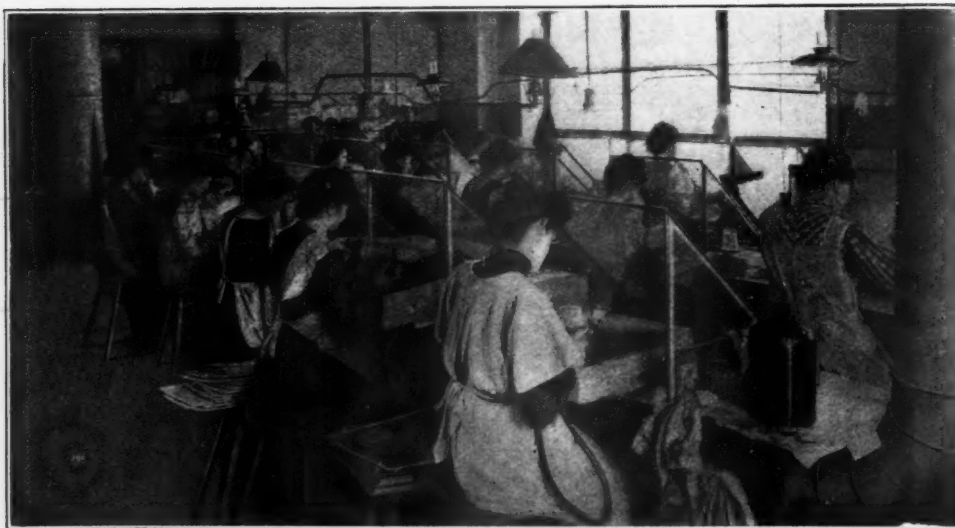
In the manufacture of certain chemicals considerable danger and expense is caused by the rapid deterioration of piping and other receptacles with which the acids and fumes come in contact. Sulphuric acid is particularly destructive and many serious difficulties are encountered in its manufacture. It is practically impossible to handle sulphuric acid with pumps, as they would deteriorate so rapidly that constant replacement would be necessary.

The most satisfactory method of pumping destructive acids is that used by the Nichol Syndicate in their new plant at Bay Point, California. At one stage of the process of manufacture, the acid is accumulated in a cylindrical tank which is provided with suitable inlet and outlet valves. When it is desired to pump the acid into other retainers, the inlet valve is closed and air at from 60 to 100 pounds is admitted, which forces the liquid through the outlet valve to other parts

of the plant. The flow of the acid is controlled by suitable valves in the piping system.

To meet the increasing demand for apparatus that will handle destructive acids economically the United Iron Works of Oakland, California, has brought out the motor driven compressor shown in the illustration. The compressor is a 6x6 Gardner-Rix Duplex; speed 200 r.p.m., pressure 60 to 100 pounds, capacity 40 cubic feet of air per minute. The compressor is driven by a Westinghouse type HF 3 phase, 60 cycle, 550 volt motor.

This type of motor is admirably suited to this work. The secondary is phase wound and the three phases are connected to the three collector rings shown. In starting, the controller gradually cuts out the starting resistance which is connected to the secondary through the collector rings. This motor is so designed that an unusually high starting torque is developed, with comparatively low starting current.



COMPRESSED AIR IN SANITARY SERVICE.

FACTORY USE OF COMPRESSED AND EXHAUST AIR

Compressed air and suction conduits, which besides their obvious employment in modern industries possess the added advantages of producing efficient ventilation without undue drafts, have recently found a use in the manufacturing of colored paper goods.

The illustration shows a room in an up-to-date factory in Berlin, Germany, where colored calendars, postcards, boxes for candies, perfumes, etc., are made in large quantities, especially for export to the color-loving inhabitants of South America. The various colors, red, blue, green and yellow, are made from aniline compounds, dissolved in alcohol. The color is contained in the small pan of a spraying device similar to an artist's air-brush, and the operator turns on the compressed air which squirts a fine spray of color over the parts of the work exposed through the pattern.

In order to catch that part of the mist of color that escapes into the air, each operator's post is surrounded by glass walls and an air suction through a slot in the table draws away the color that might escape and he inhaled, with bad effect, by the 100 or so girls who are employed in the work.

IMPORTANCE OF AIR CIRCULATION

Dr. Langlois, of Paris, has given out some interesting facts relative to the effect on mine workers of humidity, temperature and air circulation. He found at Ronchamps at a depth of about 3280 ft., with the humidity such that the dry bulb showed 36.5 degrees C., and the wet bulb 24.8 degrees C., that work could be carried on, but that, when the humidity became greater, even with a lower temperature, work became difficult. He found that with temperatures above 25 degrees on the wet bulb, the ventilation has a marked effect on the workmen's physical condition and capacity for work. In stagnant air at the temperature of 25 degrees (wet bulb), an appreciable illness is experienced, which passes off at once when the ventilating current reaches a velocity of 3.3 ft. per second. In still air at a temperature of 30 degrees (wet bulb) marked illness is felt, but conditions become supportable when the velocity of the ventilating current reaches 6.6 ft. per second. From these data it is evident that attention to ventilation in mines is an important factor in determining the labor efficiency of the underground workmen, especially in warm moist workings. Dr. Langlois found that a workman could do more work in a temperature below 25 degrees (wet bulb) when the velocity of the ventilating current is maintained at from 3.3 to 16.5 ft. per second.

HYDRO-PNEUMATIC FEED FOR RADIAL DRILL

A radial drill of new design throughout and exhibiting many novel features has recently been put out by the Walter H. Foster Co., 50 Church street, New York.

This is an electric driven machine, differing from the standard types in the combination of the saddle on the arm with a cylinder having a gear box mounted on top containing high and low speed gears in connection with a variable speed motor. The cylinder through which the spindle passes is surrounded by an oil chamber, and a piston, sliding in the cylinder is connected with the spindle which rotates in the piston and takes its thrust on ball bearings. The vertical movement or feed of the piston and spindle is controlled by the oil which fills the cylinder solidly below the piston, the pressure above the piston being supplied by a constant air pressure of 80 pounds, usually taken from the shop supply,

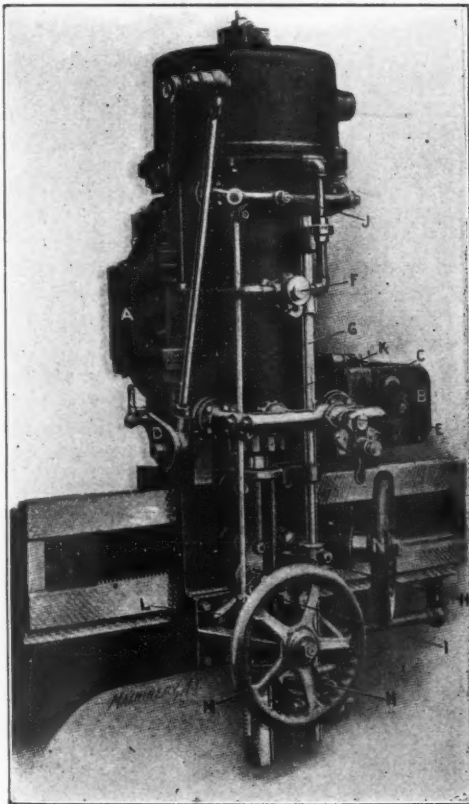


FIG. 1 PNEUMATIC DRILL FEED.

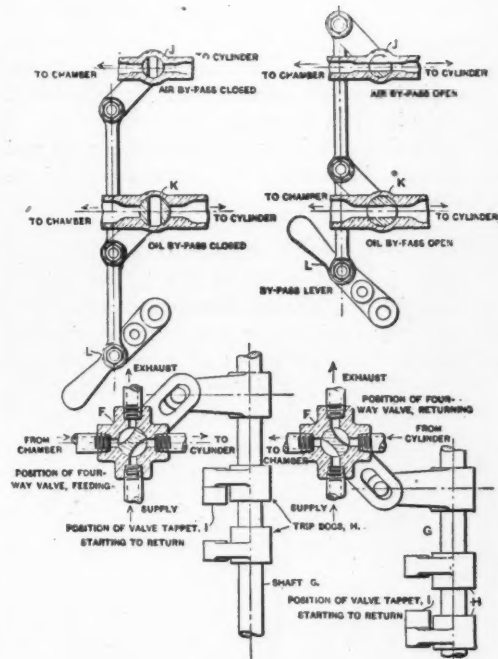


FIG. 2.

the feed movements being effected by the discharge or readmission of the oil.

Referring to Fig. 1, the motor which drives the spindle is at A. The drum type controller B is a new design, having ten points of contact, and the resistance C is attached in a neat and compact form. The feed operating valve E has a flat seat graduated to permit the passage of oil from the cylinder to the surrounding chamber, and as the air pressure on top of the piston forces it down the restricted outflow of the oil through these passages makes the feed constant. The four-way valve F controls the passage of the air, whether it is on top of the piston, forcing the spindle down (under which condition the oil is being forced into the chamber through valve E), or forcing the oil back into the cylinder under the piston, thus returning the spindle upward to its original position. The air valve is operated by the vertical shaft G which carries adjustable trip dogs H. These dogs are arranged to swing out of the way when the spindle is operated by hand, so as not to interfere with tappet I, which slides with the spindle. The by-pass valves J and K, which are operated by lever L through the connecting rod shown, allow the air and oil to pass freely in either direction

while operating by hand. The hand-wheel M has a pinion engaging with a rack for hand operation of the spindle, and handwheel N has a spiral gear engaging a rack for adjustment of the head on the arm.

The line drawings, Fig. 2, show the air and oil valves in their different operating positions.

SOUND IN THE UNIVERSE

We live and move at the bottom of an ocean of air, the earth's atmosphere. One consequence of this is that every mechanical disturbance starts waves of compression and rarefaction, which radiate out from the source, and, striking the drum of our ear, may (if of the right strength and quality) cause in us the sensation of "sound." Among such sensations some affect us merely as "noises"; in others we recognize a more or less well-defined "musical pitch" and "tone quality." Physically the "noise" differs from the "musical note" in that the former is an irregular disturbance, while the latter is periodic and of definite frequency. Not that there is any hard and fast line of demarcation: a rapid succession of impulses, which separately would be mere noises, may impress the ear with a definite sense of pitch. Thus the teeth of a saw, cutting in rapid sequence through a wooden board, produce a sound of definite pitch, though lacking perhaps in musical quality. Or again, a sharp noise of brief duration, proceeding from a point in the neighborhood of a series of equidistant obstacles, such as a line of fence-rails, or a flight of stone-steps, produces upon the observer a sensation in which a more or less well-defined pitch can be recognized. The explanation of this phenomenon is that the sound is reflected back from each fence-rail in turn, and since it takes time to travel, each echo reaches the observer a trifle later than that from the neighboring rail. This case is of special interest, because the sound "heard" contains an element quite foreign to the initial disturbance. Furthermore, the pitch of the sound heard differs according to the location of the observer, so that, borrowing an expression from optics, it might be said that the original disturbance is "analyzed" by reflection from the fence (grating) into its "constituent" waves—each traveling in its own direction, so that it can be singled out by the observer. It is possible that the means commonly em-

ployed to analyze light waves act in this way, and perhaps we are not quite justified in imagining "white" light for instance as "composed" of the various spectral colors, these being rather impressed upon it by the prism or grating or other device employed to "analyze" the light, as we commonly say.

Of all the forms of energy, sound would probably be of the least consequence to man, were it not for the one important fact, that sound is the normal vehicle for the transmission of intelligence between individuals. Certain special sounds are recognized by us not merely as "noises," or "musical notes," but as "words," which are associated in our minds with definite concepts, and whose mere mention immediately summons up before our imagination the concepts thus attached to them. Not that speech exhausts all the modes of sound-expression for mental states at our command. Indeed, more elemental and lower in the scale than speech are various inarticulate sounds, such as laughter and crying, calls of various kinds, the groan of pain, the sigh of relief, the shriek of fear, and a host of other emotional expressions. In these man approaches more nearly to the lower animals, who also possess "calls." But the range of our modes of expression by means of sound extends also on the other, the heroic side, beyond ordinary speech. The poet by rhythm and cadence conveys something more than his words alone would say, and in the symphonies of the great masters of music there is borne in upon us a wealth of thoughts that lie too deep for words.

If the ocean of air which envelopes us is the medium that carries sound to our ears, and thus places us in sentient communication with the other occupants of this globe, its shore, the void upon which the upper atmosphere abuts, is also the extreme limit of the range of space comprising all things audible to us. No sound, however loud, can ever pass from the earth into space beyond, neither can it penetrate from other orbs to us. The sun's burning eye looks down on us in splendor mute; for though his fiery ocean be lashed by furious gusts, in comparison with which the fiercest earthly gale is but as the soft sighing of the autumn wind, or as the breath of one that slumbers; and though monstrous explosions rend his very bowels, belching aloft great pillars of fire that tower thousands upon thousands of miles;

yet of all the crash and thunder and tumult not a whisper escapes to break the eternal silence of infinite space, and the empty void holds close the clamorous secret of the fiery orb.—*Scientific American*.

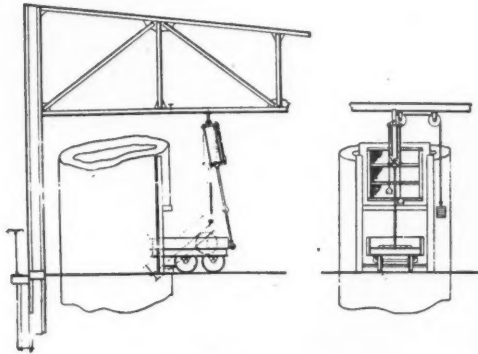


FIG. 1.

PNEUMATIC DEVICES FOR CHARGING CUPOLAS

In a paper by G. R. Braddon before the Pittsburg convention of the American Foundrymen's Association, the general subject of the mechanical charging of cupolas was discussed, including the unloading from railroad cars, the storage in the yard, the conveyance to the cupola and finally the dumping of the charge in detail into the cupola. We have here to do only with the latter operation.

Fig. 1 shows a type of charging car in which the load is carried almost entirely upon one axle, enabling the overhanging end of the car to project into the cupola and making a very light lift for the air hoist to dump the load.

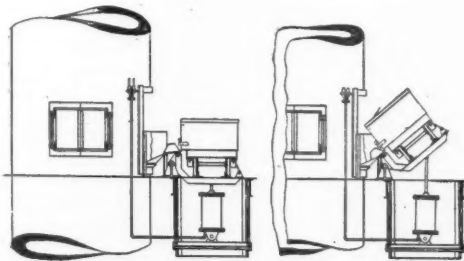


FIG. 2.

Fig. 2 shows a side dump charging machine in two positions. The car load in this case is borne equally upon all four wheels. The car is run upon a hinged platform flush with the

floor and in front of the cupola door. The platform is then tilted by the pneumatic lift below and the load slips into the cupola.

In Fig. 3 is shown a compound charging machine in both normal and dumping positions. In this arrangement the platform with the car and its load is first lifted vertically by a direct acting lift below it, and then the platform is tilted and the load is dumped by another pneumatic lift. The cylinder of the latter, it will be noticed, is pivoted at the bottom, enabling it to swing as the platform tips and giving the piston rod always a direct thrust. The air-controlling valves for either of these devices are located by the side of the cupola where most convenient for the operator.

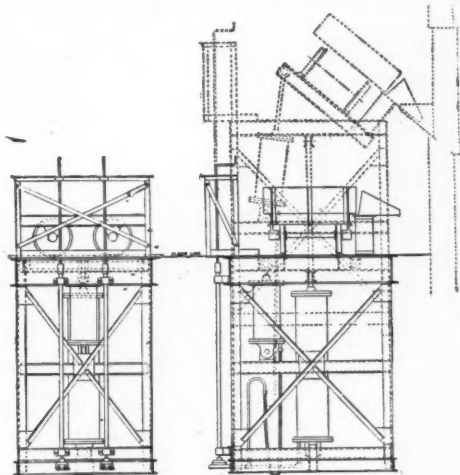


FIG. 3.

CARE OF PNEUMATIC TOOLS IN RAILROAD SHOPS

At the annual convention of the American Railway Tool Foremen's Association, held in Chicago in July, three important papers were presented relating to pneumatic tools and appliances, their reading being followed by the free and liberal discussion which prevails at the various railway conventions. The following, which can scarcely be called discussion, is a collection of brief statements of current practice in many railroad shops in the matter of lubricating, handling and maintaining pneumatic tools. The statements have been carefully abstracted by the *Railway Age Gazette*:

Mr. Martin:—We had a great deal of trouble with air motors, and employed a man who

does nothing but oil and take care of them; it has been a paying investment.

Mr. Hendrikson:—We have the air motors turned in every night and they are oiled every morning.

Mr. Linck:—There are lots of machines that ought to be oiled during the day.

Mr. Meitz:—We had considerable trouble with the motors, but we now fill the inside of the motor case with artificial engine grease. It holds the oil in the motor and the motor is better lubricated all through. It lasts twice as long and is always lubricated.

Mr. Breckenfeld:—We have a helper go around the shop twice a week; he opens the motors and packs them with No. 3 grease, as they call it; I do not believe that we have had any trouble with a motor on account of not being lubricated in six months. On Saturday night we have all tools turned in and the helper examines the motors to see that they are properly oiled.

Mr. Fuhrman:—It is a good thing to have an atomizer for oiling pneumatic tools. Fill it up twice a day; it does away with a good deal of trouble. Our system is to always keep after the motors in the tool room, and if one is not running right it is immediately returned to the tool room.

A. Stern (Chicago, Rock Island & Pacific, Chicago):—We use the automatic oilers.

J. B. Hasty (Atchison, Topeka & Santa Fe, San Bernardino, Cal.):—We pack air motors with grease once a week, over Sunday, and use grease altogether. We use a bath for the air hammers. They are turned in every evening and placed on pegs 5 or 6 in. long and are flooded at night with coal oil. The flooding arrangement is made of a reservoir in two sections; the lower section contains the oil, and the upper section the hammers; by admitting air to the lower part, it forces it up under the hammers and completely covers them with oil; they remain until morning. Just before the hour of opening, the night watchman opens the valves and the oil goes back to the lower tank; then we give them a touch of signal oil and pass them out. Nothing is done to them during the day.

Mr. Lugger:—We use the same system at our shop, but the oiling process during the day is worrying me considerably. A boiler maker takes a hammer out and after it passes into his hands in the morning, there is no oil put

in it during the day. We send out an apprentice at different times during the day who puts in a little airolene, and that has to a great extent overcome our difficulties. In our air motors, we use airolene entirely, and have no trouble. The only difficulty we have experienced of late is in the air motor throttles. They get dry, due to the men neglecting them, and we have to overhaul them frequently.

Mr. Breckenfeld:—When we know a new man is going on a job—generally an unskilled laborer in the boiler department—we try to have the men in charge of the motors go out and give him a few minutes' instruction. It has a tendency to save in the breakage of air motors.

Mr. Pike:—We have a young man go around the shop every two hours; he oils the machines through the throttle and in the case, and the gasket if necessary. If a section of hose is leaking he condemns it. These duties keep him busy. The atomizer may be all right, but it added to our troubles in that it made an additional part to maintain; also when the air line became old, small particles of rubber would pass through and clog it up; the man using the machine expected the atomizer to be on the job when it was not, and as a consequence the machine went dry. It pays to have one man to be the judge of when a machine should come to the tool room for repairs. If he hears a squeaking or grinding, it must be taken out of service. A man using a machine will use it hours after the time when it should have been stopped. We placed all air tools in an oil bath until the insurance agents objected to the large quantity of oil being kept in the building, and we now find the individual inspection very satisfactory. We experienced some difficulty after the shop had been closed down for a few days with the throttle clogging owing to dampness. We used mineral lard which amalgamates well with the moist air. It is cheap, and we use it generously and have very little trouble.

Mr. McKernan:—When a hammer is brought in throw it in a tank of coal oil. When you check it out, blow it out and oil thoroughly, and I do not think you will have very much trouble. When a hammer is kept out any length of time the man who takes it out is held responsible for oiling it. If the hammer comes back in bad shape he cannot get his check until there is a satisfactory ex-

planation, and that has to be O. K'd by the general foreman in addition to his own foreman.

Mr. Meitz:—In our shop all tools are supposed to be turned in every night. The hammers go in a bath and lie there until five minutes before work time. No tool goes out without an oiling. When they come out of the bath we hang them up to drip, and they are oiled with valve oil and signal oil mixed. Valve oil alone is a little too heavy.

William Thomason (Pennsylvania, Renova, Pa.):—We have little or no trouble as far as the use and abuse of hammers is concerned. If a hammer is neglected we find out very quickly who is responsible. When a man checks a hammer out the boy knows what hammer he gets.

Mr. Fuhrman:—I believe the foreman who has charge of the men using the tools is the man who should be responsible for their proper use. He is the best judge. Sometimes he is not in favor of saving the tools; he wants the work and may abuse the tools worse than any man. There is a limit to everything, and every foreman ought to know what will bring the best results for his company. It does not pay to spend a day making a tool and have somebody spoil it in a half hour, even though you get the work out.

Mr. Luggier:—We should not confuse severe use with abuse. A machine designed for any kind of work should be used to its full capacity all the time; we should try only to eliminate the abuse of the tool. I do not believe in nursing a tool.

Mr. Pike:—When we purchase a motor we attach a brass plate to a prominent part before it goes into service. On the plate is the name of the shop, number and size of work for which the tool should be used, i. e., "Machine shop, No. 20, $\frac{3}{4}$ in. to $1\frac{1}{4}$ in. drill; 1 in. to $1\frac{1}{2}$ in. tap." If the motor is not doing that work, we know it is the fault of the motor; it is not liable to be used on a larger tap or drill.

Mr. Martin:—We send in a breakage report which goes to the superintendent and he sends it to each foreman of the shop with a list of names and what they did in the way of breaking or damaging tools.

A pit pony has just died at New Hawne Colliery, Halesowen, Worcestershire, of Gartratts, Limited, which has worked in the mines for 40 years.

GASOLINE FROM WASTE OIL-WELL GAS

By F. W. BRADY, M. E.

[The following clear and interesting account of a recently developed by-industry of the air compressor we condense from the latest issue of *Mines and Minerals*. Ed. C. A. M.]

A striking example of waste has always been found in the great oil and gas fields of Ohio, West Virginia, and Pennsylvania. This does not mean that the oil has been wasted deliberately, for the supply is cared for remarkably well, but the direct loss has been through accident and carelessness, while the indirect loss has been from the light vapors passing off from the storage tanks, and the immense quantities of gas escaping from the wells.

Any one with a technical instinct who visits the eastern oil fields to-day will experience a feeling of relief, for the newest of the new things in oil production is the perfection of a process for manufacturing gasoline from the gas from oil wells. These plants are located here and there on the farms wherever a group of wells can be worked to the best advantage. The gasoline is shipped in 50-gallon iron barrels which are hauled by wagon to the nearest railroad station, while the by-product gas is turned into the pipe lines that for years have distributed the high-pressure natural gas supply.

Oil development is going on continually, each season seeing some new field where production is booming. At the beginning, most of the wells are self-flowing and some of them are real "gushers," producing five or six hundred barrels, or more, the first 24 hours; most of them, however, make less than one hundred barrels; the decrease of production is rapid and soon all the wells become "pumpers." At first the pumping is daily, then about twice a week, and finally a settled system of pumping once a week, or once in 10 days or so, is kept up for several years with those wells that continue to produce oil, the quantity in many cases averaging much less than 1 barrel per day. All this time, however, from the first strike of oil, and for long after the well is abandoned as an oil producer, there is a flow of gas from the well. In some cases the first strike was a "gaser," which afterwards turned to an oil producer. Generally, though, the reverse is the case, and practically all the oil wells close their careers as gasers.

Now it is this gas from the oil-bearing sands

that has made the bulk of the waste. Especially has this waste been too bad where an oil well has been abandoned and the gas has been burned on the spot from the open pipe, or has escaped freely into the air. Millions upon millions of cubic feet of nature's best fuel have thus been disposed of. The final choking up of many abandoned oil wells by salt that encrusts in the casing will really be a boon to posterity. Not only has there been a direct waste of this kind of gas, but also there has been an indirect waste in the use of the gas piped from the oil wells. In the long pipe lines it has been a common occurrence for gasoline to collect wherever a down bend or pipe would trap it. Then the re-evaporation of the gasoline will produce a freezing effect that will clog the pipes with ice where water has collected. This re-evaporation may take place where the gasoline flows from a leak in the pipe and probably within the pipe also. The freezing of the gas pipes from this cause has been annoying, but it was due to this trouble that the apparatus for manufacturing gasoline from the gas was developed.

The process depends upon the condensation and liquefaction of gases—the direct processes being dependent on the laws governing the compression and refrigeration of the gas. The present plants are equipped with a refinement of the various apparatuses that have been perfected after a considerable experimentation with one thing and another.

The general arrangement of a gasoline plant in West Virginia is shown in Figs. 1, 2, and 3, and a plan of the arrangement of the apparatus in Fig. 4. This plant has a capacity for treating 150,000 cubic feet of gas in 24 hours, and produces from 500 to 800 gallons of gasoline having a gravity of 92 degrees Baumé.

Two direct 35-horsepower gas-engine-driven air compressors compress the gas. The first compressor, which may have a piston varying from 6 to 12 inches, draws the gas from the piping system connecting all the available wells in the neighborhood. From a partial vacuum of 15 inches the gas is compressed to 20 or 30 pounds. It then passes through a water cooler to the second machine, which has a $4\frac{1}{2}$ -inch piston, and which compresses to 150 pounds or over. The final pressure must be determined by trial, as the process depends considerably upon the quality of the gas and the refrigeration treatment. Thus in this plant 150 pounds compression was found to produce more gasoline than did 250 pounds compression.

The gas at 150-pounds pressure passes through an 80-foot water cooler, and then through a double 80-foot gas cooler, the latter using the by-product gas for cooling. The collecting and separating tank is of heavy boiler plate construction and resembles a 40-horsepower vertical boiler. The saturated refrigerated gas under a pressure of 150 pounds or over, enters the side of the accumulator tank at a point about two-thirds its height, measured from the bottom. A baffle plate riveted in the tank deflects the flow and pre-



FIG. 1. GASOLINE PLANT.

cipitates the gasoline. The accumulation of gasoline is shown by a gauge glass, and periodically the attendant blows it into a storage tank of 120-barrels capacity. A similar storage tank, located below the first one, is shown in the foreground of Fig. 3. The storage supply stands at about 20 pounds pressure. From the stock tanks the gasoline is loaded into iron barrels of about 50 gallons each.

The gas engines are of the tandem type and supplied with two flywheels. The gas-engine cylinder is at the head end and the gas compressor cylinder next to the crank end. Both the engine and compressor cylinders are water-jacketed. The crank case on some of these engines is closed and has a vent pipe leading above the building; thus, any gas leaking from the cylinders will be carried out of the building and the danger from fire or explosions is lessened. The make-and-break spark system is used for ignition, and a friction-driven magneto for each engine is located in a small building some 100 feet distant. A small gas engine operates these magnetos and also the generator for lighting the plant. An air starting outfit, consisting of one air pump compressing to 150 pounds, air receiver, starting valves, pressure gauges, etc., makes the starting of these large gas engines an easy and a safe

operation. About 2 pounds gas pressure is used for the gas-engine service. A regulator placed outside the building is necessary to deliver the fuel at a uniform pressure.

Cooling System.—All the engine and compressor cylinders are water cooled. The gas as



FIG. 2. GAS COOLER, ACCUMULATOR AND LOADING HOUSE.

it comes from the wells is probably at 60 degrees F. The heated gas from the first compression goes to a water cooler consisting of a concrete vat 20 ft. \times 4 ft. \times 4 ft. A continuous flow of cool water passes through this tank in which a 10-inch pipe is laid lengthwise along the middle and to which the 3-inch delivery pipe from the first compressor is attached at one end, while to the other end an inlet pipe to the second compressor is attached.

The high-pressure gas from compressor No. 2 passes first through an automatic separator that removes any lubricant that may be carried

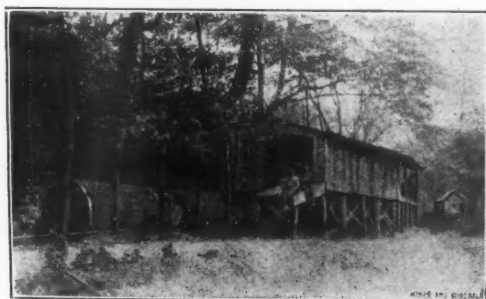


FIG. 3. STORAGE TANKS LOADING HOUSE AND MAGNETO BUILDING.

over from the compressor. It also catches any gasoline that may drain back from the second cooler.

The second cooler is 80 feet long and consists of a concrete tank like the intermediate cooler. A 10-inch pipe is placed lengthwise of the tank. The arrangement of the piping sys-

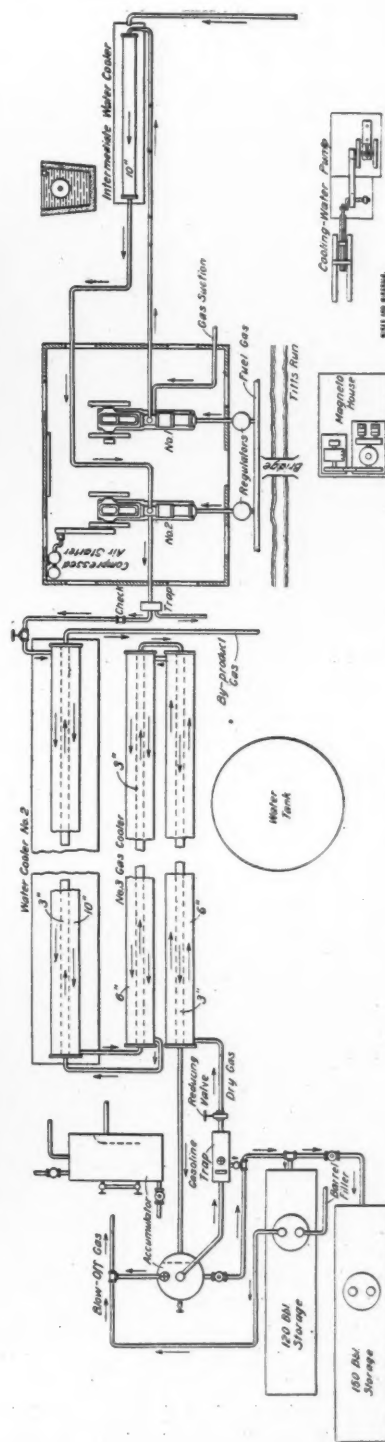


FIG. 4. LARGEST OF GASOLINE PLANTS.

tem for the second cooler and also that for cooler No. 3 is shown in Fig. 4. The 2-inch delivery pipe enters a special fitting at the rear end of the 10-inch pipe, and the water-cooled gas passes out a 3-inch pipe 80 feet distant. This 3-inch pipe enters the end of an 80-foot length of 6-inch pipe, and returns through a second 80-foot length of 6-inch pipe and thence to the accumulator tank. From the gas space in the top of the accumulator tank a pipe leads to a gasoline trap which collects any gasoline that may be carried over from the accumulator and returns it to the stock tank. This trap is also fitted with a pop safety valve that relieves the accumulator from any over pressure and delivers the gas that may be blown off to the fuel-supply gas mains. Above the gasoline trap the by-product gas passes through a reducing valve and enters at low pressure the lower 80-foot branch of the 6-inch gas cooler. This No. 3 cooler is made up of a loop of 6-inch pipe laid in a box packed with sawdust.

The peculiar design of the cooling system makes it necessary to use some specially designed pipe fittings. The cooling effect of the expanded by-product gas is considerable, as it flows 160 feet through the 6-inch pipe that encloses the 160 feet of 3-inch pipe carrying the compressed gas to the accumulator. From the 6-inch gas cooler, the expanded gas goes to the 80-foot water cooler and passes through a 3-inch pipe laid lengthwise through the center of the 10-inch pipe. From cooler No. 2 the by-product gas goes through a 2-inch pipe to the gas engine feed-line. The by-product gas not used by the plant goes into the natural gas mains and is sold. The overflow water from the concrete tanks flows by gravity to the water-jackets of the engines and compressors. The by-product gas is a blue-flame gas that is more desirable for fuel and lighting than the raw gas, as it does not deposit any soot or blacken at all the furnaces, gas mantels, cooking utensils, etc.

The partial vacuum produced by the first compressor as it draws its gas supply from the wells aids both the oil and the gas production; in fact, in some cases the gas is given to the gasoline plants, by the oil man, as the increase of oil due to the vacuum is quite an item to the well owner. At the same time, however, the owner draws back all the by-product gas he needs for pumping the oil.

The vacuum in the field lines is one of first importance in gasoline production. So great

is this feature that in some gasoline plants a special independent low-stage vacuum pump and gas compressor has been installed so as to regulate the field pressure and increase the production. This machine can be operated at any desired speed necessary to keep the pressure conditions constant. With this low-pressure compressor 24 inches or more of vacuum can be held on the wells, and at the same time the efficiency of the regular compressor units not be lowered. The advantages observed from the use of the vacuum system have led to the reopening of abandoned oil fields, not for the oil but for the gas from which they make gasoline.

The business of making gasoline from natural gas is necessarily a hazardous one. It is a new business, and this, coupled with the usual combinations of ignorance and carelessness, makes a list of accidents that one would naturally expect. Even the empty barrels have exploded when standing exposed to the hot sun and with the vent plugs set tight. On one occasion an empty went up when standing on the freight station platform. Those old in oil-well service have become accustomed to handling nitroglycerine, and while they respect it, they treat it with a feeling of contempt. On the other hand, gasoline of from 92 degrees to 100 degrees Baumé is a new thing to them, and they have got "burned" as a consequence. Therefore, to hear an operator about a gasoline plant remark that he would rather carry "nitro" than gasoline is evidence of the fear in which it is held.

Gasoline cannot be produced from all natural gases, at least not in paying quantities. As a general thing, the paying proposition is in connection with oil wells. In some cases the profits have been very great, and in the present state of the art it is not believed that the highest efficiency is yet attained. Any one can see that the process is one of conservation of the very best order, and fetches to the owner "a smile that won't come off."

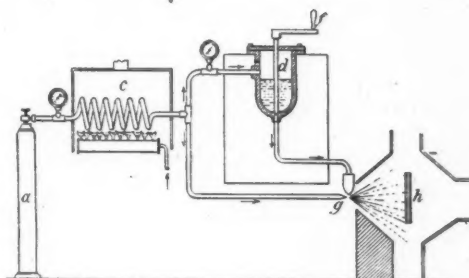
After a test of one month at the Gorgona shops, Panama, the sand blast method of cleaning, and the pneumatic painters in use, have demonstrated the economy of the method over the former method of hammering the scale from the cars and painting them by brush.

NEW METHOD OF METAL COATING

A Swiss engineer, M. Schoop, has invented a new process for producing a metal coating on various metals, by spraying a cloud of finely atomized metal particles upon the surface to be covered. The new method was first demonstrated before the Engineers' and Architects' Association at Zurich, and has since been presented also before the French Academy of Sciences by Prof. D'Arsonval.

The metal is melted in a crucible *d* and is allowed to escape by a capillary opening *g*, under a pressure placed upon the surface of the melted metal by compressed air or other gas. Just after emerging from the opening, the thread of melted metal escaping under pressure is atomized by a gas or steam spray, so as to form a cloud of finely-divided metallic particles. Through this cloud is passed very rapidly the object which is to take the coating. An inert gas is best used to give the pressure on the melted metal, while another kind of gas can be used for the atomizing. If desired, such a gas may be used at this stage as will oxidize the metal, so as to give a coating of oxide instead of metal. The action of depositing the metal appears to be as follows:

When the metal is atomized in the form of a cloud, its particles strike the surface which is to be covered, but here they lose their original spherical form and are flattened out upon the surface into blotches which unite together and form a continuous layer of a certain thickness over the object. The metal is projected at a very great speed from the orifice, and this explains why the particles which are no longer liquid when they reach the surface of the object, are able to make up a homogeneous and very compact layer whose density is about the same as for the metal in its usual state, as experiments made at the Zurich laboratory have shown. Even though the metal has been melted in the crucible, the vapor is not very hot when it is projected out by this process, so that there is no difficulty in depositing it upon readily combustible substances, such as paper, wood, celluloid, or even animal tissues. The deposits of metal thus prepared are much harder than those obtained by the usual methods. For instance, tin, when cast, showed only a little over one-half the hardness of tin applied by the Schoop



METAL COATING APPARATUS.

process, when tested by the Brinell method of dropping a steel ball and observing the mark made by it. Under the microscope there appeared to be no difference as to the fineness of the structure as compared with the ordinary metal.

The new process lends itself to a number of interesting and useful applications, since most of the common metals can be deposited in layers upon various surfaces. One very important use should be the coating of structural iron to protect it against weathering. The operation should be readily applicable to finished structures, such as cranes, bridges, etc. There should be no difficulty in making the coating apparatus portable, so that it can be used on the spot to coat the ironwork all over with a non-rusting metal layer more durable than any kind of paint, and, as the inventor claims, also more economical. Numerous applications which suggest themselves for the new process might be divided into two classes. On the one hand we may wish to coat an article for decorative or protective purposes; on the other hand the aim may be to form a crust over an article, in order to subsequently strip it off in form of a mold. Additional uses of a somewhat different character are the coating of wood, porcelain or glass, to render their surfaces conductors of electricity; and the metal coating of glass mirrors, whether parabolic, spherical, plane, or of any other kind.—*Paris Correspondent, Scientific American.*

One of the most marvelous things is the burning of a jet of hydrogen gas in liquid air. The smoke that arises from the combustion floats off in the air as pure snow. A flame burning brilliantly in the midst of a liquid, with snow given off for smoke!

COMPRESSED AIR LEAKAGE ON THE PANAMA CANAL

A series of tests has been made of the air mains in the Central and Pacific Divisions to determine the amount of waste from all causes, and the proportionate share of the cost that should be borne by each division. It was found that there was practically no leakage in the main between the Rio Grande compressor, and the beginning of the Pacific Division lines. On June 11, a test of all the mains and laterals showed a total loss of air of 24.89 per cent on the basis of the output of May, of which only 5.8 per cent. was on Pacific Division lines. At the time of the test, the flow of air into the Pacific Division mains was measured by a meter. It has been determined to cut out all laterals for the Pacific Division, north of the flow meter, and, since there is practically no leakage between the compressor plant and the meter, the proportion of cost of air compressing to be borne by the Pacific Division will be determined by the flow through the meter.—*Canal Record*.

HIGH ALTITUDE TESTS ON BLOOD

Under the auspices of the British Royal Society, Dr. J. S. Haldane and Dr. Gordon Douglas, both of Oxford University, England, and Dr. Yambell Henderson, of Yale University, New Haven, Conn., have begun a series of experiments on the summit of Pike's Peak, Colorado, to determine the effect of high altitude on human blood. The two former last summer experimented in this matter on top of Teneriffe, off the west coast of Africa. Their findings indicated that at high altitudes the red corpuscles of the blood increased in proportion to the amount of blood in the body. The object of further experiments is to determine whether the number of red corpuscles is actually increased, or whether the blood simply thickens by evaporation of water. In this connection it might be of equal interest and value to have the effect on respiration and the blood accurately determined by penetrating into deep mining shafts.

DRILLING RECORDS OF HAMMER DRILLS

Hammer drills in a Pennsylvania limestone quarry, where the stone is hard but is readily chipped, drilled holes of about 1¾ in. diameter to a depth of 4 ft. in 18 minutes, and in a test run 14 in. of hole was drilled in 4½ minutes.

Sharp bits were found to cut 3 in. more than dull ones in a test run of 4½ minutes. No trouble was experienced with sludge in depths up to 5 ft. Similar drills sunk rows of holes for cutting sandstone blocks in an Ohio quarry at the rate of 25 sec. per hole of 18 in. depth. In block-holing hard granite in a crushed-stone quarry, holes averaging 18 in. in depth, but reaching 48 in. in some cases, were drilled at an average rate of 1 in. per minute, the speed sometimes reaching 2½ in. per minute. The air pressure averaged 80 lb. per square inch. In this case six men, each with a hammer drill, replaced 18 hand-drillers at a saving which is summarized as follows: Eighteen hand-drillers, at \$1.50, \$27. Six hammer drillmen, at \$1.50; air-compressor operator, \$3.50; one ton coal, \$3; repairs, 60 cents; oil, etc., 30 cents; interest on plant, 60 cents; total, \$17. This gave a saving per day of \$10. The blacksmithing is not included as it was about the same in both cases.—*Engineering Record*.

WD DO NOT BELIEVE IT

GRAND FORKS, B. C., June 3.—An English sparrow flew into one of the compressor wheels at the Granby smelter April 15 and came out alive when the works was shut down recently. The wheel is thirty-three feet in circumference and travels 110 revolutions a minute. According to calculations, the bird traveled 40,590 miles in its forty-one days' journey. The bird lived without food or water, but was apparently in good condition when the compressor shut down, as it flew around the office several hours before escaping.—*Press Dispatch*.

[The arithmetic is not correct, anyway, and compressors are not run so long without a stop.—Ed. C. A. M.]

"I saw a sight down in Oklahoma last week that I never witnessed before," said "Jim" Findlay yesterday. "I saw 8,000 acres of wheat being threshed by a gas-driven threshing machine. Two immense gas wells were recently brought in near Ponca City, in Kay county, and Miller Bros., of 101 Ranch have piped the gas three miles to their ranch. The big wheat field is gridironed with pipe lines and the thresher is moved about the field, coupled to one of the pipe lines and started by the striking of a match.—*Kansas City Journal*.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established, 1896

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CONTENTS

Air Compressor Testing.....	6155
Condition of Gas in Coal.....	6157
Gas Lighter than Hydrogen.....	6158
Subterranean Temperatures	6159
Record of Rock Drilling by Hand.....	6159
Building Concrete Drop Shafts.....	6160
Air Conditioning for Factories.....	6162
Panama Compressor Lubrication.....	6163
Aviation Makes Speed Records.....	6164
Sulphuric Acid and Compressed Air....	6165
Factory Sanitary Compressed Air Service	6166
Importance of Air Circulation.....	6166
Hydro-Pneumatic Feed for Drill.....	6167
Sound in the Universe.....	6168
Pneumatic Charging of Cupolas.....	6169
Care of Pneumatic Tools.....	6169
Gasoline from Waste Gas.....	6171
New Method of Metal Coating.....	6175
Air Leakage on Panama Canal.....	6176
Altitude Tests on Blood.....	6176
The Universal Coal Carver.....	6177
The Atmosphere and the Soil.....	6178
Compressed Air Misinformation.....	6179
The British Air Race.....	6180
Tunnel Air and Rail Corrosion.....	6180
Notes	6182
Patents	6184

THE UNIVERSAL COAL CARVER

While we are looking after the savings in practical coal mining there is nothing more really worth saving, nothing which it is more necessary to save, than the time and strength of the miner. The operation of coal getting is simply that of cutting out successive portions of the embedded mass. A knife such as that with which a loaf of bread is cut would be the ideal coal carver, but no one yet has found it. Next to that would be a saw, but the saw insists upon conditions which make it also impracticable, and the best we can do by any mechanical contrivance yet developed is to cut in slits as narrow and deep as possible and then to break the coal away by light blasting or otherwise.

The coal puncher idea is to work in a slit horizontally as far as possible under the coal and then break it down. Although it is not a very thin or precise slit that the coal puncher makes, still it suffices, and the device enables the men to get out more of the coal in a given time, but the handling of the machine profitably cannot be anything but real and strenuous work. The puncher, although getting to be extensively used, still insists upon its conditions. Its work is simply that of undercutting in seams nearly level. When pitching seams are to be worked there is additional labor in holding and handling the machine, and even then the incline must be only a slight one.

Here the radialaxe comes in, to work at any angle just as well as at any other. It does not necessarily take hold in cases where the horizontal working puncher is balked, but it can do all the work of the puncher right through. When the radialaxe is actually working the operator's work in manipulating it is easy. As compared with handling the puncher the man may be said to be resting when he is working. There is more work, in fact, in setting up and securing the radialaxe than in running it, but this is no more than the handling of the ordinary rock drill.

The precision with which the radialaxe bit is carried and guided makes the cut as thin as possible, so that comparatively little fine coal and dust is produced. This precision of location and perfect control of direction constitute an important feature when the radialaxe is used in cutting out a fireclay or slate band, such as often occurs in a seam, and which, if

not removed, impairs the market value of the entire output. It would scarcely be thought that it could be provided for the proprietor of a coal mine to be able to boast of the excellence and purity of his product on account of the precision of working of the machinery employed, this being usually the privilege of the manufacturer alone.

Thus far we have thought of the radial-axe coal cutter as taking its cut from the puncher and doing its work also horizontally or in planes paralleling the seam, but in addition to this it cuts out lines of employment for itself which are independent of the puncher. Its more comfortable, and, as we might say, more natural, way of working is in making vertical cuts, and in some cases by this means it may put the puncher entirely out of business. It may be used to rapidly cut a central slit vertically in the face of the coal, and then the coal can be broken down and thrown out by light shots, or otherwise.

The work of the machine may be laid out in the mind as the making of either lines or dots. The lines may be horizontal or vertical or at any angle, representing the slits or cuts which it is the business of the machine to make, and the dots are simply holes driven directly forward, as the radialaxe, stopping the radial feed, is besides all else a complete rock drill. Such a machine acts not only to conserve the effort of the coal miner, but also of the material which is being cut, and thus in a double sense becomes an element in the conservation of natural resources.

ATMOSPHERIC AGENCIES AND SOIL ACTIVITIES

Considering the soil factor, or more properly, factors, it is now clearly recognized that the living plant, or at least that part of it in the soil, the root, is always in motion while the plant lives. The soil solution, the natural nutrient medium for plants, is always in motion; for when water falls upon the soil there is always a movement into and through the larger soil interstices, mainly by gravity, and when the precipitation ceases there is immediately surface evaporation accompanied by a return to the surface of a portion of the absorbed water through the capillary interstices and in films over the soil grains. In like manner, the soil atmosphere is constantly changing, and it is obvious that the life of insects, bac-

teria, etc., in the soil is a process of growth and decay, and therefore of constant change.

The solid particles of the soil are likewise always in motion. The activities of insects, crawfish, earthworms, burrowing animals, etc., in translocating soil material are now recognized as being, in the aggregate, very large. Freezing and thawing produce considerable motion of soil material. It has recently been shown that every change in the moisture content of a soil is accompanied by necessary movements of the soil particles, and by changes in their state of aggregation, and it is obvious that under field conditions a soil is always either drying out or being wetted.

Besides these movements of the solid soil particles, resulting in profound changes from time to time, not the least of which is an interchange of the material between soil and subsoil, there is constantly in process a translocation of soil material from field to field, from area to area, and frequently over large distances. As a result, soils are notably complex as regards their composition—more complex by far than the individual rocks or rock magmas from which they have been derived; and, speaking generally, practically all soils contain all or nearly all of the common rock-forming minerals.

To produce this state of affairs, two natural agencies are competent—water and wind. The effect of water action in translocating soil material is enormous, but restricted by the facts that water can run down hill only, and is but occasionally in action. The effects of wind action are quite as important, for the wind is constantly in action, to a greater or less extent, and blows up hill as well as down. While the effects of water action may be more striking and impressive, the effects of wind action are quite as important, from the point of view of the soils, if not of the surface geologist.

It is clear that not only has the wind been an important agent in the past in soil translocation, but that it is equally important to-day, not only in forming and modifying great deposits and areas of soil, but in modifying and affecting more or less profoundly every farm and field. It is one of the most important factors in the complex system of soil movement affecting soil fertility. No fact in our knowledge of the soil is now more clearly defined than that the soil of a particular field is not

just the soil that was there a few years ago, or just the soil that will be there a few years hence. Moreover, it appears that when this translocation is at a "normal" it is beneficial, and an important agency in maintaining fertility. But when excessive, "wind erosion" is one of the most baneful of the farmer's troubles. Its prevention and control is therefore one of the great practical problems of agriculture, one easily met in the majority of cases, but sadly neglected, nevertheless. Methods for controlling the action of the wind must be devised. Windbreaks, cover crops, rotation schemes, cultural and other methods are actually in use to this end, more or less successfully; but in few localities can it be said that the problems have been met with complete success, and an unusual opportunity is open for experimental work of a most useful kind.—*Bulletin No. 68, Bureau of Soils, Dept. of Agriculture.*

MISINFORMATION ON COMPRESSED AIR PRACTICE

[The following interesting matter is a portion of an article upon "Compressed Air in Mines," by Richard Sutcliffe, which appeared in a recent issue of *The Iron and Coal Trades Review, London*. We reprint it here chiefly as a curiosity. The article ostensibly and quite earnestly advocates the use of compressed air in mines. It may have been written a quarter of a century ago and just now resuscitated for publication. Whenever written it is more wrong than right all through, its errors being so glaring that it is not here necessary for us to call the attention of our readers to them in detail.]

Many and various attempts have been made to produce a satisfactory air compressor, but such an one has not yet been built, nor, in the writer's opinion, is there likely to be one whilst the matter is treated so illogically by makers of this class of machinery. But a little time ago we were asked to expect great things from compressing air in stages. These great things, however, have not materialized. Sixty pounds per square inch is ample pressure for all requirements, and this is easily got without stage compression; indeed, higher pressure is inconvenient for coal-cutting, conveying, and such-like machinery, where hose pipes have to be used.

In order to deal properly with compressed

air it must not be considered as though it were steam, for although compressed air and steam are alike in some essentials, they differ widely in others. In order to get the best results from steam it must be used at a high temperature and hence the most economical are the high-speed engines, and as compressing is done at present it is possible in speeding up the engine to over-run the compressor and so get no compressed air at all. The cause of this is, of course, that we have only atmospheric pressure to fill the cylinder and operate the inlet valves. A further disadvantage of the high-speed compressor is that the air is unduly heated, a clear proof that the best work is done by the slow-running machine.

Even when the air is compressed in the present illogical manner, it is all too often allowed to waste in dribbles before doing any useful work. If, as is often the case, this happens on the surface, what may we expect below ground, when it is remembered that there are 586 joints in each mile of pipes laid, so that a small leak at each joint must and will leave a low pressure or small volume at the far end. These are trifles, perhaps, and in practice are too often forgotten or ignored, but they are trifles which are continuous and persistent and often form the dividing line between success and failure.

In former years the installation of such plants was often of an experimental nature and seldom received the care and forethought they now claim, and although every colliery manager knew that the friction of air in motion varied with the square of the velocity multiplied by the rubbing surface, etc., yet 3-in. or 4-in. pipes were the sizes often chosen to convey the air, with the result that there was not a working pressure at the coal-cutters, even when the compressor was blowing off at 60 lbs. pressure or more. Where air has to be transmitted, say for a mile, to two or three coal-cutters, the pipes should not be less than 8 in. in diameter, and the smallest leakage should not be permitted in the whole distance.

To sum up the subject of the use of compressed air in mines, it certainly appears that were it more expensive than it really is, it would still be a most desirable adjunct, even if used solely as a factor of wise precaution. In order to produce compressed air economically, it should be done by a slow-running compressor, whatever the form of prime-mover em-

ployed to operate it. The compressing engine should be fitted with governors actuated by the air pressure so as to prevent waste in blowing off air at the receiver. With these few precautions compressed air is quite capable of economical use in operating the various machines below ground, and with the present trend of legislation will probably be the only practical operating power permitted beyond the safe zone at the pit bottom.

COMMENT AND SUGGESTION ON THE BRITISH AIR RACE

The air race carried out in these islands since our last issue cannot be described from whatever point of view we regard it as anything else than splendid. As a spectacle it was inspiring; as a significant indication of the progress being made in aeronautical engineering it was surprising; and as an exhibition of sheer brutal pluck on the part of the aviators competing, it was magnificent. To fly over a set course of a thousand miles or so, and to do this in the face of fog, hail, rain, and blinding sun, is in itself a sufficiently great achievement for these early days of the art. But when we reflect that at least two of the aviators, "Beaumont" and Vedrines, kept to the scheduled time allowed for the different sections of the route with a precision which many railways might envy, we begin to grasp some idea of the portent which the art of artificial flight bears for the future and of which the shadow is already at our feet.

Add one other fact. Before the race commenced five essential parts of each aeroplane and five essential parts of each motor were officially stamped. For a competitor to establish a claim to the prize at least two of each sets of parts of his machine had to pass through the entire contest unchanged. As a matter of fact, the winner returned with all the marked parts in position. Here surely is proof that the engineering side of aviation is no less wonderful than the other. Man and motor have conjointly been tested, and the verdict pronounces them as equally successful. Twenty-one competitors left Brooklands last Saturday afternoon, and of these seventeen reached Hendon hard on one another's tails. Since then one by one their number has been diminished through accident and delay until, as Edinburgh, Glasgow, Carlisle, Manchester, Bristol, and Brighton were in turn passed,

principal interest settled down on four, "Beaumont," Vedrines, Valentine, and Hamel. The first named was the first to reach Brooklands on the return trip, and won the £10,000 prize offered by the *Daily Mail*.

But when all is done, when the prize is awarded, and when the sensations of the moment abate, some thought may perhaps be given to the cost of such a race. We do not mean the monetary cost—for aviators have every chance of becoming wealthy at a moment's notice—but the cost in the way of lost nerve power and of shortening of life which the strain of flying exacts from the aviator. The rapidity with which an aviator springs into public prominence is almost equalled by the suddenness of his retreat as an active exponent of his art. Those who a year ago were foremost in the field, and who have escaped the death continuously waiting for them while they were flying, have all retired from the active participation in public contests. The reason for this is only too obvious, and while we believe that chance is being gradually eliminated from the domain of aeronautics, it is certain that the nervous tension to which an aviator is subject during all the time of a flight is a more serious barrier, and one which will have to be reckoned with in the near future. It will, for instance, almost certainly entirely preclude for all time the participation of the majority of people in the pleasures and dangers of artificial flight.—*The Engineer*, London.

TUNNEL AIR AND THE CORROSION OF RAILS

Mr. Percy Longmuir in a paper before the Iron and Steel Institute of Great Britain, gives an account of investigations of the acid corrosion of rails in tunnels on the main lines of several English railways, involving analyses of tunnel air, tunnel water and the scale on the rails.

One of the distinct features in connection with the corrosion of steel by atmospheric action is an appreciably high content of sulphur. Samples of rust taken from widely different localities and environments showed distinctly higher sulphur content than the steel from which the scale was formed. Samples from main-line rails at four points remote from each other showed a sulphur content of 0.24 to 0.37 per cent. in open situations, and

in one case, in a cut leading to a tunnel, showed 0.57 per cent., or, in terms of SO_2 , 0.61 to 0.93 per cent. and 1.44 per cent., respectively. The general investigations in this connection show that samples of rust from rails laid in normal positions do not contain less than 0.2 per cent. sulphur, whereas the average sulphur content of British rails is below 0.06 per cent.

The difficulties of sampling tunnel atmospheres were recognized, in that a variation in the currents of air was found even in the absence of traffic, and a variation of the sample with the level from which it was taken. The results were therefore taken to refer only to the particular sample, and not necessarily as indicating the general conditions. Five samples, taken within a period of two hours in one wet tunnel, showed an acid content of 0.08 to 0.24 per cent., four out of the five being above 0.16 per cent.

In the same tunnel the sulphur content of the air was shown by the fact that water draining into the tunnel contained sulphates to the extent of 0.25 grains per gallon, expressed as SO_2 , whereas that draining away from the track in the tunnel contained 1.59 grains per gallon and that standing in stagnant pools contained 13.60 grains per gallon.

An examination of the sooty deposit on the side walls showed the presence of 2.83 per cent. of sulphur, of 7.10 per cent. of SO_2 . Two analyses of corroded deposits from the rails in the tunnel showed 3.68 and 2.89 per cent. of sulphur, respectively, or 9.22 and 7.29 per cent. of SO_2 .

About the same time as the above, an investigation was made of a second main-line tunnel, which was well drained, had no standing water and was generally of a dry character. Four samples of the air, taken within $1\frac{1}{2}$ hours, showed acid traces in two cases and 0.10 per cent. acids in the other two. In general the acids were practically negligible in the tunnel air.

NEW BOOK

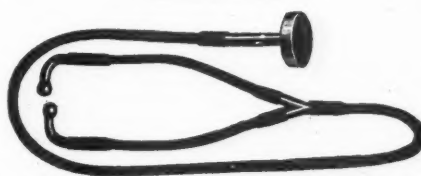
Railway Shop Kinks. Compiled by Roy V. Wright, New York, *Railway Age Gazette*. 290 pages, 9x12 inches, 803 illustration, \$2.

The prizes offered by the *Railway Age Gazette* for shop "kinks" from railway shops brought out an astonishing number of labor-saving or otherwise profitable apparatus and contrivances in actual and successful use

which were successively shown in the pages of that journal and are here reproduced in similar form. The work in railroad shops is so nearly like that of steam engine and machine shops in general as to render these kinks widely applicable. Pneumatic devices are shown in great variety.

Practical Applied Electricity. By David Penn Moreton, B. S., E. E., Chicago. The Reilly & Britton Co., 440 pages 7x4½ inches, 340 illustration, \$2 net.

This, as the title page further tells us, is "a book in plain English, for the practical man." It is a clear, concise and comprehensive compendium of information such as the man of the ship or the man who is in charge of or in any way has to do with electrical apparatus will need to know. The language is plain, the computations are simple and the examples are to the point.



AN AIR COMPRESSOR STETHOSCOPE

The little halftone above shows an air compressor or steam engine stethoscope or knock finder. It is applied to cylinders, valve chests and other parts where there may be internal and abnormal knocking, known or suspected, and it intensifies the sound in a way which greatly facilitates the locating of the trouble.

No explanation is required. The sensitive corrugated diaphragm is lightly pressed against the machine surface and whatever knocking there may be within is greatly intensified as it reaches the ears through the air tubes. The instrument is moved about over the surface until the point of greatest sound intensity is found which locates the knock within. It can of course be used upon moving machinery of all types.

The Vibracator, as it is named, is made by Hopewell Brothers, Newton, Mass.

TESTING THE "CEMENT GUN" AT PANAMA

A test of the cement gun as a means of coating the surface of rock in Culebra Cut to prevent disintegration is in progress. The

so-called "gun" is a compressed air apparatus [described in COMPRESSED AIR MAGAZINE, June, 1911] for forcing cement and sand from a tank through a nozzle, at the mouth of which water is mixed with these materials, forming a concrete which is cast upon the surface to be coated with such force as to become part of the rock itself. For the work in Culebra Cut, the apparatus is mounted on a flat car, at one end of which, is a bin for mixing the sand and cement. One day's supply is carried, or enough to coat 200 square yards with a layer one inch thick, in nine hours of work. The car was rigged up at Empire shops, and the machine was tested by allowing it to coat a boiler with asbestos. Five men are required in operating the plant, their work including mixing and delivering the materials, and operating the gun.—*Canal Record*.

NOTES

A single block of stone estimated to weigh 8000 tons is reported as recently blasted out in the Wilkensen stone quarries, Washington. It was about 56 ft. long by 50 ft. high, which should make its third dimension about 35 ft.

Some astonishing engine speeds were noted in a recent automobile race in England. One engine made 2,490 r. p. m. and 1,794 feet per minute piston speed as an average for the race, the maximum speeds being considerably higher.

Ammonia refrigeration tanks exploded July 30 during a fire at Brockton, Mass., which destroyed the Satucket Block and part of the Holbrook Building. Three firemen were badly injured. The tanks were a part of the cold storage plant of the Brockton Public Market Co.

A mine rescue tournament will be held at the experiment station of the Bureau of Mines at Arsenal Park in Western Pennsylvania on Sept. 16. Contests will be held in first-aid work, fire fighting and the use of oxygen helmets, and a number of new safety devices will be given a trial.

In one minute, in a state of rest, the average man takes into his lungs about 8 liters or 48.8 cubic inches of air. In walking, he needs 16 liters or 97.6 cubic inches; in climbing, 23

liters or 140.3 cubic inches; in riding at a trot, 33 liters or 201.3 cubic inches; and in long distance running, 57 liters, or 347.7 cubic inches.

The Illinois Traction System has equipped some of its new cars with air signal whistles in the place of bell signals for the use of conductors in signaling the motormen. The signal is operated by a bell cord, but the air whistle is believed to be more certain of operation than the bell. If this proves to be the case the whistles may be installed on all the cars of the company.

We are becoming familiar with denatured alcohol and now we are beginning to hear of denatured sugar, which in France is not to be subject to duty when used by textile manufacturers in spinning and weaving. The crystallized cane sugar is to be mixed in fixed proportions with blue vitriol. Glucose also comes under this heading, including invert sugar and dextrose, which are to be mixed with formaldehyde and ammonia sulphate.

The preservation of iron in concrete is again attested in the demolition of an old gasometer at Hamburg, Germany, as reported by *Fer et Acier*, of Brussels. This structure was built about 1852 and when taken down the iron anchor bolts which had been completely encased in a cement concrete were found to be as fresh and bright as new iron, with no traces whatsoever of rust.

At the laboratory of the Mines Company of America's property at La Colorado, a device for drying pulp and slime samples is installed which is of interest, because of its simplicity and effectiveness. Instead of drying the samples by heat, the moisture is extracted by a vacuum process, employing the principle of the Moore filter. A canvas is stretched across the bottom of a small sample-drying pan, and the vacuum applied at the bottom by a hand pump. The pans are 6 in. across and 2 in. deep.

The Hungarian government has decided to monopolize the tremendous natural gas source recently discovered at Kissarmas, in Transylvania, of which the daily yield amounts to 26,000,000 cu. ft. This is the most important

source of gas in the world so far discovered. The gas comes out of the ground at a pressure of over 30 atmospheres. In view of the tremendous pressure, it is quite impossible to reach the orifice of the well, which promises to become a source of wealth for the whole country.

In 1908 the total value of stone products in the United States was \$65,712,499.00, of which Vermont produced \$7,152,624.00 and stood for the first time a leader. Of this total \$18,420,080.00 represented the value of granite. Vermont produced \$2,451,933.00 and led all states. The value of marble produced during that same year was \$7,733,920.00, of which Vermont supplied \$4,679,960.00 and again stood first. Of the slate produced the totals are not obtainable, but it is certain that Pennsylvania led Vermont.

It is stated in *Cosmos* that recent researches seem to indicate that ozone is far from being the ideal air sterilizer and purifier. In experiments especially directed toward determining the efficiency of ozone in workshops it was found that while the reduction in the number of microbes was manifest, so that perfect sterilization by its use could be obtained in 10 or 12 hours, a desirable degree of purification could not be obtained unless the percentage of ozone passed the limit where it begins to be noxious, if not dangerous, to the human organism.

The volume of carbonic acid exhaled by a human being in the course of twenty-four hours is put at about 100 gallons; but by Boussingault's estimate, a single square yard of leaf-surface, counting both the upper and the under sides of the leaves, can, under favorable circumstances, decompose at least a gallon of carbonic acid in a day. One hundred square yards of leaf-surface then would suffice to keep the air pure for one man, but the leaves of a tree of moderate size present a surface of many hundred square yards.

East of the Missouri River in South Dakota, it is estimated, more than one thousand artesian wells now exist, drawing their water from the supply carried by the underlying sandstone formation, and supposed to come from the Black Hills and the Rocky Moun-

tains. These wells, used mainly for irrigation purposes, are from 500 to 1,000 feet deep, and the pressure of water in the eastern part of the State is sufficient to give a surface flow, except on the highest lands. One well yields 3,292 gallons per minute, and furnishes power for a flour mill by day and for an electric light plant by night.

The city of Sherman, Tex., has recently closed contracts for the purchase of machinery for pumping water from wells in connection with the water-works system by means of air compressors. The contracts were placed with the De La Vergne Machine Co., 1107 E. 138th street, New York, for one 180-horse-power type "FH" engine, and with the American-Diesel Engine Co. of St. Louis for one 170-horse-power Diesel engine. Each engine is to operate a 700-foot Ingersoll-Rand two-stage compressor and a small triplex pump, both pump and compressor to be operated by belts from the engines.

A large subaqueous tunnel is approaching completion at Hamburg, the work having been in progress about five years and the cost approximating \$2,640,000. The tunnel is being driven 20 ft. below the bed of the River Elbe and comprises two tubes 19.88 ft. in diameter and 1476 ft. long; the river is about 33 ft. deep at midstream. The tunnel ends at the one bank in the suburb of St. Pauli and at the other in Steinwarder, another suburb of Hamburg. The buildings on both sides of the river forming the entrances to the tunnel, with their copper-coated domes and ornamented with reliefs and pillars, will constitute noteworthy sights of the town. At each entrance there are six elevators for pedestrians and vehicles.

The fixation of atmospheric nitrogen for fertilizer purposes is growing rapidly in importance, and its remunerativeness is plainly shown in the report presented recently at a stockholders' meeting by the president of the Norske Hydroelektriska Aktie Selskap, Norway, which is capitalized at about £400,000. During last year dividends amounting to 8 per cent. on the preferred stock and 5 per cent. on the common stock were paid. The gross earnings during the year amounted to £240,000, of which £70,000 was net income. The company is now developing, in conjunction with other financial

interests, some 135,000 h.p. in different parts of Norway, all to be applied to the manufacture of nitrates from the atmosphere.

In a few months an interesting engineering feat will have been accomplished in Hamburg. This is the construction of a gigantic tunnel beneath the river Elbe which has cost nearly eleven million marks, and has now been in progress for nearly five years. The tunnel, which comprises two tubes 6.06 m. in diameter and 450 m. long, is 6 m. beneath the bed of the river, which in the middle is 10 m. deep where the tunnel crosses. The tunnel ends at the one bank in the suburb of St. Pauli and at the

stamps) to the Commissioner of Patents, Washington, D. C.

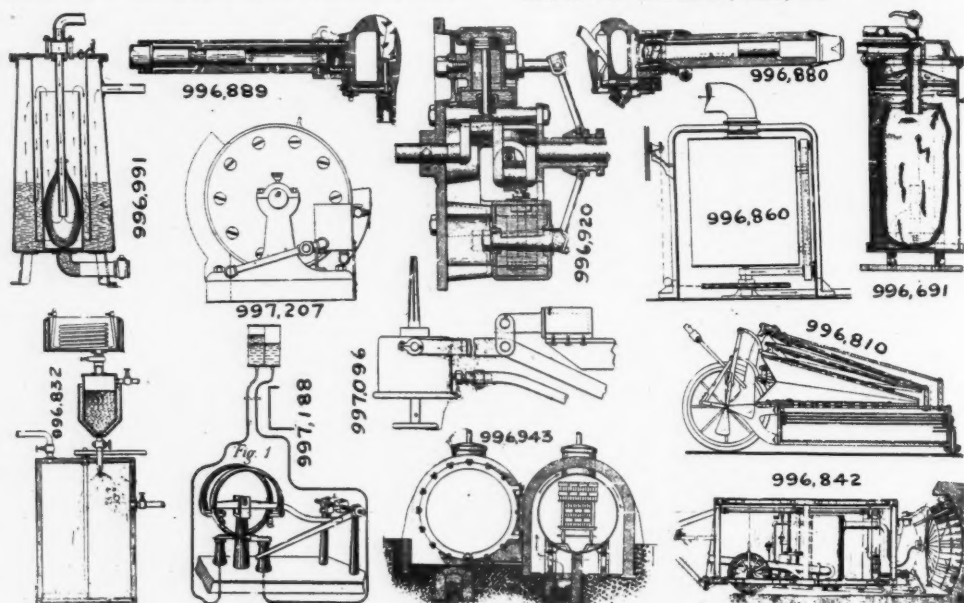
JULY 4.

996,691. **CLEANING APPARATUS.** JAMES L. WALLACE and HARVEY WALLACE, Chicago, Ill.
996,705. **PROCESS OF PURIFYING AIR.** ANSON K. CROSS, Winthrop, Mass.

2. The method of purifying air comprising passing it through a suitable liquid electrolyte and adding to the air oxygen which is formed by electrolysis of the liquid performed in such a manner that the oxygen is conducted into the air current while the other gaseous constituent of the electrolyte is prevented from mixture with the air.

996,771. **APPARATUS FOR DRYING AIR.** JAMES B. KING and WILLIAM E. HUGHES, Clyde, Ohio, and FRANK W. HALL, Detroit, Mich.

996,810. **PNEUMATIC CARPET-CLEANER.** HAROLD M. STURGEON, Erie, Pa.



PNEUMATIC PATENTS JULY 4.

996,832. **DESICCATING MILK.** CHARLES H. CAMPBELL, New York, N. Y.

996,842. **TUNNELING-MACHINE.** GEORGE A. FOWLER, Denver, Col.

996,850. **COMBINED OZONE GENERATOR AND INHALING APPARATUS.** ROBERT P. GUILLEY, Akron, Ohio.

996,860. **APPARATUS FOR CLEANING AIR OR GAS FILTERS.** PAUL KESTNER, Lille, France.

996,880. **PNEUMATIC HAMMER.** SAMUEL OLDHAM, Philadelphia, Pa.

996,889. **PNEUMATIC HAMMER.** HENRY SCHUMACHER, Denver, Colo.

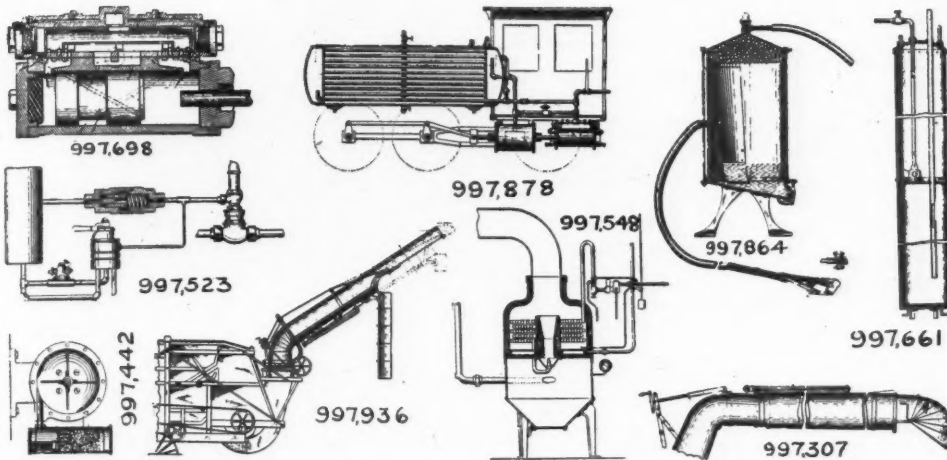
996,920. **TRANSMISSION-GEAR.** JAMES H. GIBSON and HENRY L. WHITMAN, St. Louis, Mo.

2. In a transmission gear, the combination of a pair of shafts, one of which is provided with a plurality of cranks, and a plurality of fluid controlled means, each carried intermediate of its ends by the other shaft and each having a piston way and by-pass located wholly therein.

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other in Steinwarder, another suburb of Hamburg. The buildings on both sides of the river forming the entrances to the tunnel, with their mighty copper-coated domes and ornamented with reliefs and pillars, will constitute noteworthy sights of the town. At each entrance there are six elevators for pedestrians and vehicles, which operate almost without attendants, the starting, speeding up, slowing down, and stopping all being effected automatically.



PNEUMATIC PATENTS JULY 11.

and pistons in the piston ways having piston rods connected in pairs with said cranks.

996,943. **DRIER.** LOUIS E. ROGERS, Chicago, Ill.

1. The combination with a kiln for burning clay articles, of a substantially air-tight drying chamber, a housing inclosing said chamber and spaced apart therefrom, a waste heat conduit connected with the kiln and provided with openings in said conduit whereby the heat is caused to circle exterior of the chamber and to communicate heat thereto, and means for maintaining a partial vacuum in the chamber to withdraw therefrom the vapor generated by the heat from the articles being dried therein.

996,991. **VACUUM APPARATUS.** PAUL C. LITTLE, Carnegie, Pa.

997,096. **PNEUMATIC REAMER.** JOHN S. SCHOFIELD, Gershom, Forest Hall, and JOHN SWIFT, Hull, England.

997,207. **AIR-MOTOR.** JAMES PETERACEK, Oberlin, Kans., administrator of Anthony Kolsky, deceased.

13,266. (Reissue). **METHOD OF PREPARING**

LIQUID HYDROCARBON FOR COMBUSTION. EDWARD J. WIGGINS, Chicago, Ill.

1. The method of preparing liquid hydrocarbon for combustion, which consists in conducting separately liquid hydrocarbon and air, both in unheated condition, to a point of mixing the two while in such condition, spraying the unheated mixture in its course to the point of consumption into the atmosphere, thereby atomizing it while in such unheated condition and mixing more air with the resultant fluid, and thereupon immediately subjecting the mixture to a "cracking" temperature in said course.

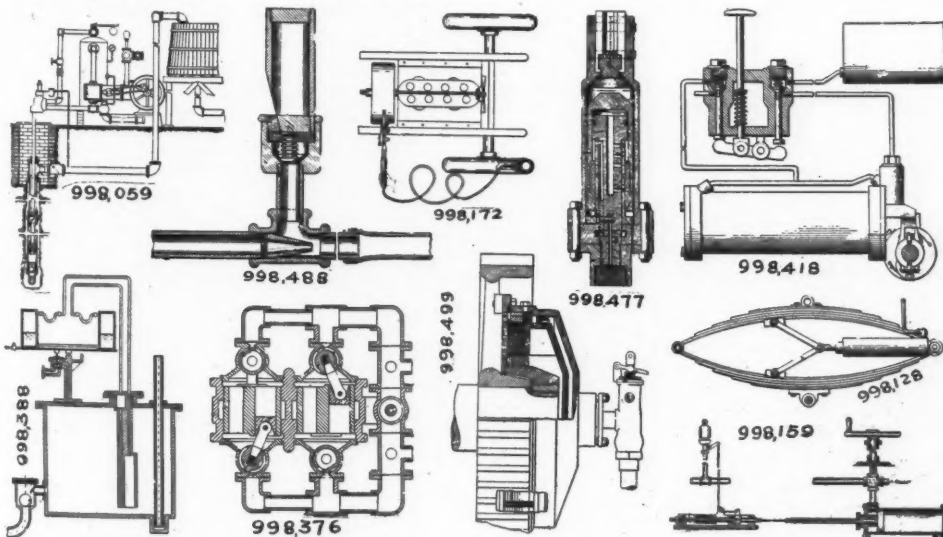
JULY 11.

997,307. **PNEUMATIC STACKER.** WALLACE F. MACGREGOR, Racine, Wis.

997,339. **OZONIZER.** JAN STEYNIS, New York, N. Y.

997,442. **AIR FILTER AND PURIFIER.** HARRY K. DIFFENDERFER, Lancaster, Pa.

997,523. **DUPLEX PRESSURE-CONTROL APPARATUS.** WALTER V. TURNER, Edgewood, Pa.



PNEUMATIC PATENTS JULY 18.

- 997,548. VACUUM CLEANING APPARATUS. LOUIS W. G. FLYNT, Rochester, N. Y.
 997,661. PNEUMATIC WATER-ELEVATOR. VERNOR L. ELLISON, Shawnee, Okla.
 997,698. MINING-MACHINE. ERNEST PENBERTHY, Painesdale, Mich.
 997,732. PUMP FOR PORTABLE VACUUM-CLEANERS. IRVING K. BAXTER, Utica, N. Y., and CHARLES F. BARRETT, Bridgeport, Conn.
 997,864. VACUUM-SEPARATOR. HERBERT A. SIMPSON, Homer, Mich.
 997,872. AIR-COOLING MACHINE. WILLIAM W. WALLER, Washington, D. C.
 997,878. HOT-AIR LOCOMOTIVE. SAMUEL J. WEBB, Minden, La.
 997,936. PNEUMATIC STACKER. FREDERICK L. SATTLEY, Indianapolis, Ind.

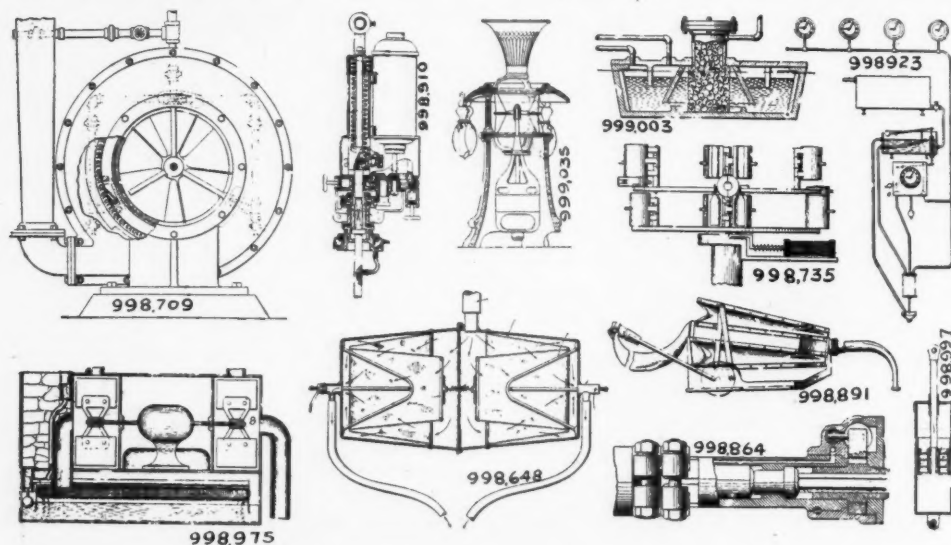
JULY 18.

- 998,059. PUMPING SYSTEM. FREDERICK C. WEBER, New York, N. Y.

- 998,313. PNEUMATIC-ACTION FOR PIANOS. PETER WIGGEN, Chicago, Ill.
 998,376. FLUID-PRESSURE APPARATUS. THOMAS MOSS, Portsmouth, and WILLIAM MOSS, Wigan, England.
 998,388. VALVE-GEAR FOR APPARATUS FOR RAISING LIQUIDS. HARRY PAULING, Gelsenkirchen, Germany.
 998,418. ENGINE-STARTING DEVICE. GREGORY J. SPOHRER, Franklin, Pa.
 998,477. PNEUMATIC HAMMER. CHARLES F. DUVAL and HENRY MCDERMOTT, Leadville, Colo.
 998,488. SIGNAL. BARRINGTON FERGUSON, Fernie, British Columbia, Canada.
 998,499. FLUID-OPERATED SAFETY-CLUTCH. WILLIAM ALEXANDER GORDON, Shelton, Conn.

JULY 25.

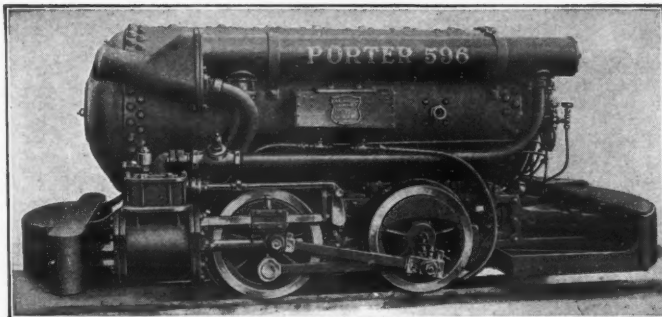
- 998,648. DUST-COLLECTOR FOR VACUUM CLEANING SYSTEMS. GULBRAN SNIPEN, St. Louis, Mo.



PNEUMATIC PATENTS JULY 25.

1. In a pumping system the combination of a source of fluid pressure supply, a liquid chamber having inlet and discharge valves, means for admitting fluid pressure from said supply to said chamber, and for exhausting said pressure therefrom, said means including a differential pressure and gravity actuated valve.
 998,111. SAND-BLAST APPARATUS. JOHN D. MURRAY, San Francisco, Cal.
 998,115. COMBINATION VOLTMETER, AMMETER, AND PNEUMATIC PRESSURE-GAGE. LOWELL P. NORTON, Los Angeles, Cal.
 998,128. COMBINED AIR PUMP AND CUSHION. BENJAMIN W. SMITH, Montpelier, Ind.
 998,157. STARTING DEVICE FOR GAS-ENGINES. GUSTAV CHEDRU, Buffalo, N. Y.
 998,159. DEVICE FOR BLOWING WHISTLES ON VESSELS. JOHN S. CLARKE, East Cleveland, Ohio.
 998,171. PNEUMATIC FOR AUTOMATIC PLAYER PIANOS. AXEL G. GULBRANSEN, Chicago, Ill.
 998,172. PUMP FOR INFLATING RUBBER TIRES. CYRUS A. HAAS, St. Louis, Mo.
 998,201-2. REGULATOR FOR FLUID-COMPRESSORS. WARD RAYMOND, Easton, Pa.
 998,226. PNEUMATIC HAMMER. GEORGE L. BADGER, Quincy, Mass.
 998,659. PNEUMATIC TOOL. WILBER H. VAN SICKEL, Philadelphia, Pa.
 998,709. TURBINE-BLOWER. WILLIAM MCCLAVE, Scranton, Pa.
 998,735. MACHINE FOR FORMING AND BLOWING GLASS ARTICLES. JOHN I. ARBOGAST, Pittsburg, Pa.
 998,841. HOSE-COUPLES FOR AIR-BRAKES. NELSON CLEGG, Neodesha, Kans.
 998,864. ROTATION DEVICE FOR FLUID-PRESSURE-OPERATED HAMMER-TOOLS. ALBERT H. TAYLOR, Easton, Pa.
 998,891. VACUUM-CLEANER. JOSEPH E. GEARHART, Clearfield, Pa.
 998,910. ROCK-DRILLING MACHINE. PAUL LANGE, Brieg, near Breslau, Germany.
 998,919. PNEUMATIC HAMMER. REINHOLD A. NORLING, Aurora, Ill.
 998,923. PNEUMATIC CLOCK. PIERRE POETTO, Paris, France.
 998,975. HEATING, COOLING, AND VENTILATING SYSTEM. FRANK P. MIES, Chicago, Ill.
 998,997. PNEUMATIC SHOCK-ABSORBER. GIUSEPPE TARAGLIO, Rome, Italy.
 999,003. PROCESS OF OBTAINING NITROGEN. CHARLES E. ACKER, Ossining, N. Y.
 999,035. AIR-CIRCULATOR. JAMES KEITH, London, England.

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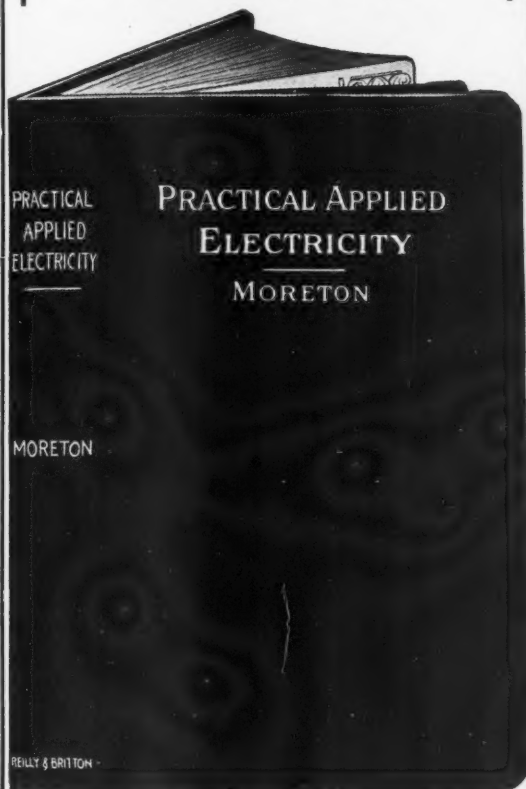
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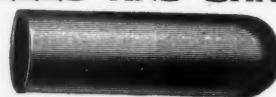
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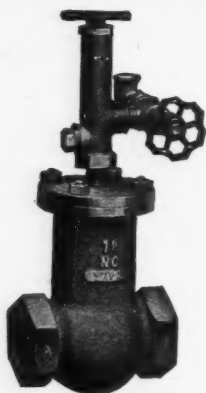


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By ROBERT PEELE

Mining Engineer and Professor of Mining in the School of Mines, Columbia University

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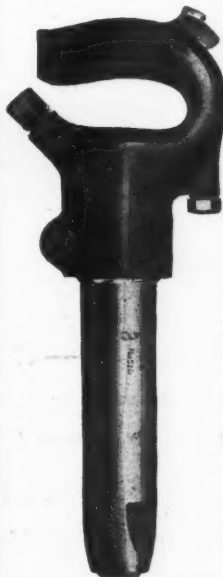
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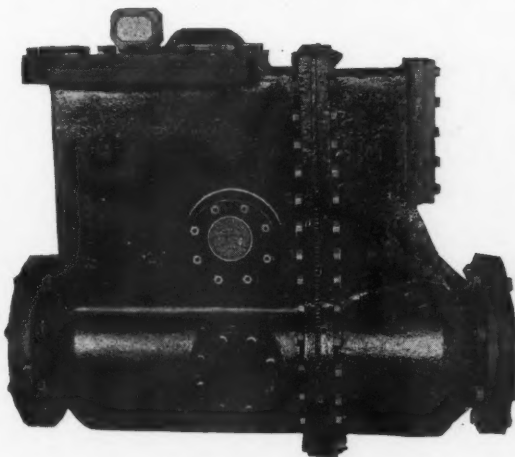
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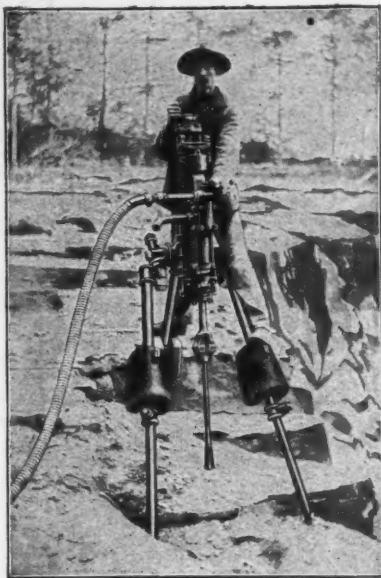


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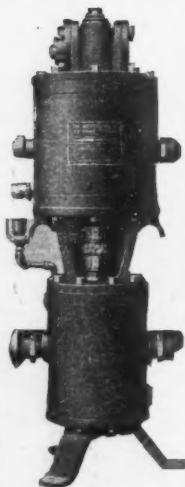
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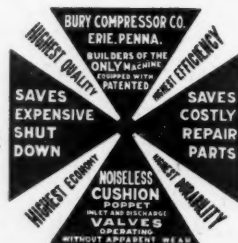
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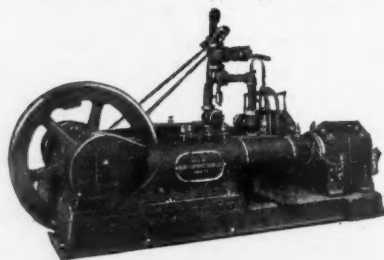
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